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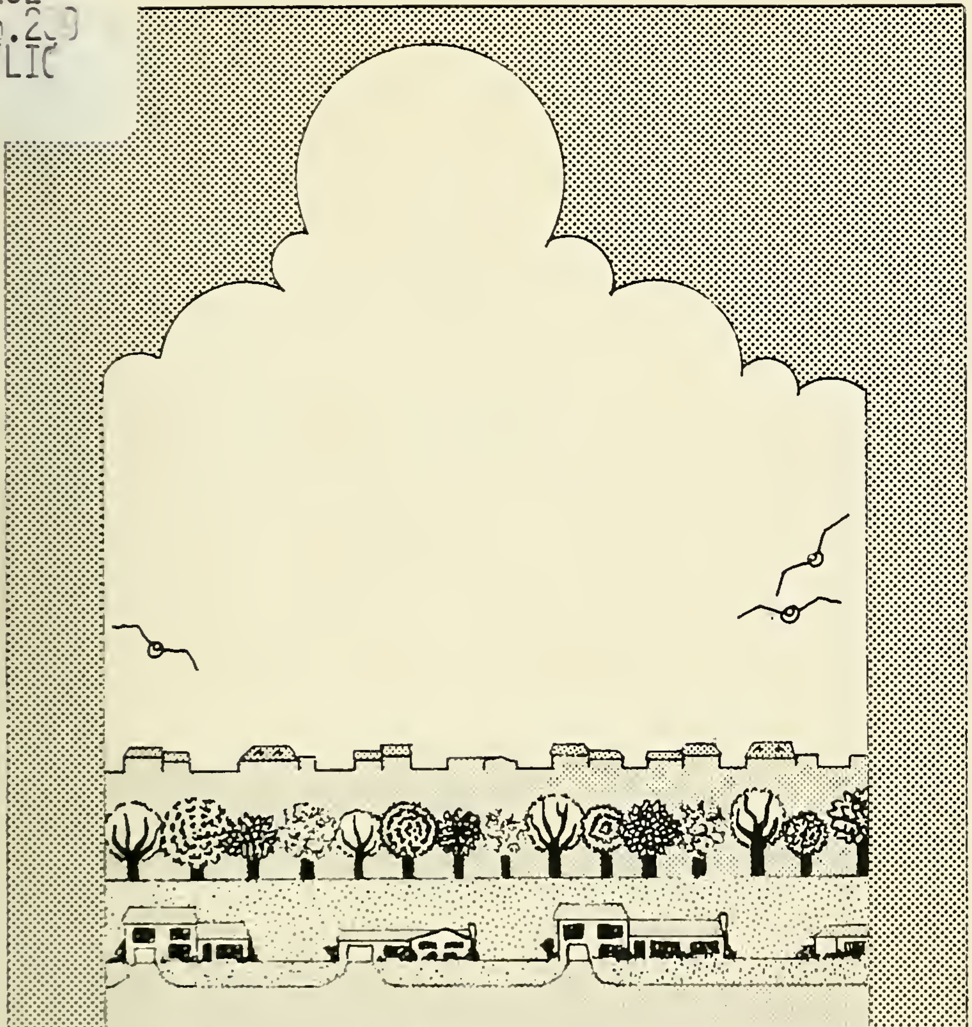
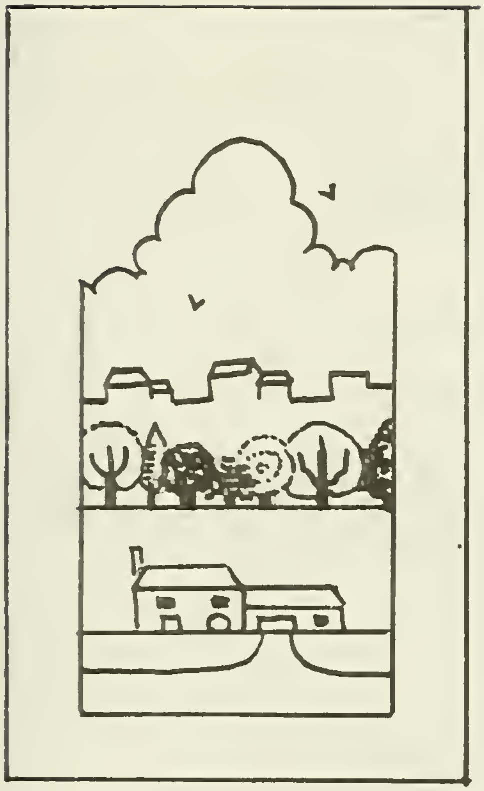


THE LAND USE CLASSIFICATION SYSTEM

technical series may 1974

Generalized Land Use Plan

Maryland Department of State Planning



THE
LAND USE
CLASSIFICATION
SYSTEM

Publication.

Maryland Department of State Planning

TECHNICAL SERIES MAY 1974

GENERALIZED LAND USE PLAN

HONORABLE MARVIN MANDEL
GOVERNOR OF THE STATE OF MARYLAND

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Publication No. 209

May, 1974

THE LAND USE CLASSIFICATION SYSTEM

Erratum

Page iii   William Bioone should read William Brooner

There is no existing minerals map for Talbot County

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MARVIN MANDEL
GOVERNOR

VLADIMIR A. WAHBE
SECRETARY OF STATE PLANNING
MADELINE L. SCHUSTER
DEPUTY SECRETARY

MEMORANDUM

DATE: August 26, 1974

TO: Maryland Room, McKeldin Library, University of Maryland

FROM: Department of State Planning

RE: Transmittal of Department of State Planning Publication #205 Geology, Aquifers, and Minerals and #209 The Land Use Classification System

As required by Section 53, Article 40 of the Annotated Code of Maryland, as amended by House Bill 1076 of the 1972 State Legislature, enclosed for your reference are copies of the Department of State Planning's recent publications, Geology, Aquifers and Minerals and The Land Use Classification System. Three sets of county maps, designed for use with these publications, are being forwarded to you under separate cover.

Enclosures

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MARVIN MANDEL
GOVERNOR

VLADIMIR A. WAHBE
SECRETARY OF STATE PLANNING
MADELINE L. SCHUSTER
DEPUTY SECRETARY

MEMORANDUM

To: Report Recipients August 26, 1974

From: Vladimir Wahbe Vladimir Wahbe

Enclosed are copies of Geology, Aquifers and Minerals and The Land Use Classification System, the latest in the series of technical manuals being published by the Department of State Planning as part of the land capability analysis of the Generalized State Land Use Plan.

Geology, Aquifers and Minerals describes the major geologic formations, aquifer systems and mineral resources in Maryland in terms of their ability to support various land uses. This manual is designed for use with two sets of county maps, one depicting the geologic formations and aquifer systems, the other locating the mineral resources throughout the State.

It is important to note that while the information contained in this manual and on the maps is appropriate for the purposes of the Generalized State Land Use Plan, it is not suitable for determining site-specific information about a given geologic formation, aquifer system or mineral deposit. If this information is desired, more on-site investigation, including a series of chemical and physical tests, must be done.

The Land Use Classification System describes and summarizes land use inventories compiled by the Maryland Department of State Planning. These inventories provide a current picture, as well as an historic record, of the State's land use patterns.

A copy of the recently completed 1973 land use inventory accompanies the manual. The 1973 land use inventory series has been prepared on a county basis for each county in Maryland. These maps are at a scale of 1:63,360 (1 inch equals 1 mile). The maps incorporate a significant amount of information beyond the detail of the initial 1970 Land Use Map Series.

As in any technical report, errors may occur in these manuals and maps despite every effort to minimize inconsistencies. If such an error comes to your attention, please notify us so that we can edit future editions and inform other recipients.

If you have any questions about the data in this manual or would like further information about the land use planning activities of the Department, please contact me.

TITLE: Maryland Land Use Classification Schemes

AUTHORS: William Bioone - Earth Satellite Corporation
Alex Wolfe - Maryland Department of State Planning

DATE: May, 1974

SUBJECT: The Maryland Department of State Planning has recently compiled a series of statewide land use inventories. This report describes the methodologies and characteristics of each of the land use inventories and classification schemes and is designed for use with a series of county maps locating the various land uses throughout the State.

AGENCY: Maryland Department of State Planning

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H.U.D. Project No. ND-P-1008-100

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No. of Pages - 74

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Charles County #9
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Frederick County #7
Garrett County #7
Hartford County #4
[illegible] #6
[illegible] #8
[illegible]

Prince George's County #[illegible]

Queen Anne County #7
St Mary's County #10
[illegible] County #[illegible]

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Washington County #7
Wicomico County #5
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PREFACE

The Legislation creating the Maryland Department of State Planning (Articles 41 and 88C, Annotated Code of Maryland) assigns to the Department the responsibility of preparing and updating "a plan or plans for the development of the State, which plan or plans collectively shall be known as the State Development Plan." Based on this responsibility, numerous special studies and projects have been or are being completed by the Department of State Planning, including a study of the Chesapeake Bay, a study of State Wetlands, an Outdoor Recreation and Open Space Plan, and a Historic Preservation Plan.

In addition to the above studies, the Department of State Planning is currently preparing a State Development Plan, which will provide a coordinated program to guide the future development of the State to assure the general welfare and prosperity of the people of Maryland. This plan will be based on studies of social, economic, and physical conditions and trends in the State and will examine these parameters within a goals-oriented framework. The plan as presently defined has two major elements, the Land Use Plan and the Human Resources Plan, in order to emphasize equally the best use of the State's physical resources and the well-being of its citizens.

The Land Use Plan will describe desirable general patterns for the development of land related facilities and services, as well as suggest policies for the management of the State's natural resources. It will include:

1. A statement of the goals, policies, standards and criteria upon which the plan is based;
2. Recommendations for the most desirable general pattern of land use within the State;
3. Recommendations for the major transportation facilities and services within the State which are consistent with and supportive of the Generalized Land Use Plan;
4. Recommendations for the major public facilities and services which are consistent with and supportive of the Generalized Land Use plan; and
5. Recommendations for the actions required to implement the plan.

The methodology utilized for the development of the Land Use Plan was based upon four assumptions.

1. That the State Land Use Plan sets the State's Policy for utilization of its land resources, facilities, and services;
2. That the plan is based upon an evaluation of the State's characteristics, land resources, and citizens' needs and aspirations;
3. That priority selection must take place between alternate and sometimes conflicting land uses;
4. That the plan and process can have a substantial impact upon the future quality of life and growth of the State.

There are several methodological phases necessary to prepare the Generalized Land Use Plan. They are:

1. Preliminary research and analysis
2. Capability analysis
3. Suitability analysis
4. Goal and policy formulation
5. Preliminary development of land use plan alternatives
6. Review of alternatives and final plan selection

The capability/suitability phases forms the heart of the plan's methodology, providing base information for continued work. Within the context of the Land Use Plan, capability refers to the ability of land to support particular uses based upon the relevant physical characteristics of the land.

Capability analysis involves the selection of those factors most important for specific land uses by identifying areas of the State which can best support those types of land use. The Department of State Planning has outlined the following parameters for the capability analysis:

1. Percentage of slope as an indicator of topography
2. Floodplain delineation
3. Soil characteristics
    a. Agricultural productivity
    b. Erosion susceptibility
    c. Permeability
    d. Depth to bedrock
    e. Depth to water table
    f. Stability
4. Wildlife and fish habitats
5. Forests by type
6. Geological setting
    a. Type
    b. Hardness
    c. Stability of cuts
    d. Durability
7. Aquifers
8. Mineral resources
9. Unique natural features and scenic areas
10. Surface water quality

Suitability analysis refers to the consideration of those variables in addition to the above which relate directly to private and public expenditures or facilities that are programmed over long periods. It allows priority selection among areas of the State equally capable of supporting various land uses. The following factors are to be considered in the plan for the purposes of suitability analysis:

1. Existing and proposed land use
2. Existing and proposed sewer service
3. Existing State and Federally owned lands
4. Existing local and regional plans
5. Historical structures or areas
6. Existing and proposed transportation facilities
    a. Airports
    b. Road intersections
    c. Pipeline rights of way
    d. High voltage electric
    e. Ship channels
    f. Rapid transit rights of way

For reasons of economy, no new data was gathered in the preparation of the capability and suitability analyses of the Land Use Plan. Instead, existing information was converted into suitable formats and within this constraint, every effort was made to interrelate, balance, update, translate and transform the diverse data sources. Of necessity, then, ad hoc decisions were made by the Department of State Planning regarding the selection and analyses of data, based upon existing available information.

This manual is one of a series produced during the preparation of the capability and suitability analyses of the Land Use Plan. These manuals have been prepared so that the major assumptions and techniques utilized in the development of the planning data base are available to those not directly responsible for its production. Through this procedure, citizens of the State can become aware of the utility and the limitations of the data base and then can suggest their own inputs to the planning process, such as data improvements or policy considerations. The Department of State Planning is concerned that too often general plans have been developed and adopted for a particular area, but have not been accepted by its citizens because the plan methodology could not be understood. In the public sphere, perhaps more than in any other, an understanding of the planning methodologies is as important as an understanding of the adopted plan. Both must be acceptable if any plan is to be given a sufficient level of credulity so as to make it truly effective. These manuals are designed to foster such an understanding.

ACKNOWLEDGEMENTS

The authors recognize that their primary contribution in this document has been to assemble in a single source the many contributions of others too often unrecognized. The products reported in the following pages have been prepared over a period of four years and through the combined efforts of federal agencies (particularly the U. S. Geological Survey's Geographical Applications Program and the National Aeronautics and Space Administration), State agencies (particularly the Comprehensive Planning Section of the Maryland Department of State Planning), and private consultants to the Department.

Particular acknowledgements are due to Messrs. Edwin L. Thomas and John C. Antenucci for their support and guidance to the land use inventory programs for over four years; to Ms. Pam Danko for her assistance in preparing the land use maps associated with this report; and to Mr. Jack B. Bale for particularly constructive ideas and editorial contributions.

The programs contributing to this report were financially supported, in part, by the following:

Department of Housing and Urban Development
'701' Planning Assistance Grant

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Earth Resource Technology Satellite (ERTS)
Program

SECTION 1:
MARYLAND LAND USE INVENTORIES

INTRODUCTION

The Maryland Department of State Planning has recently compiled a series of statewide land use inventories. The use of remotely senses data sources, specifically aerial photography, and compatible land use classification schemes was common to each inventory. This report describes the methodologies and characteristics of each of these land use inventories, and illustrates how the historical set which they form will be used in Maryland's comprehensive planning effort.

In the Introduction (Section 1), general characteristics of land use classification schemes and inventories derived from aerial photography are discussed. Section 2 considers the current land use inventories for 1970 and 1973. The 1970 Land Use Inventory was acquired through the cooperation of the U. S. Geological Survey. Many of the mapping techniques and classification scheme concepts used in other Maryland Land Use Inventories resulted from the 1970 efforts by USGS. The 1973 Land Use Inventory was undertaken as a result of extensive evaluations of the 1970 inventories and developments resulting from research performed under a grant from NASA to the Department of State Planning. The 1973 Land Use Inventory contains a refined classification scheme and a more detailed mapping effort which is directly supportive of the Department's program to develop a Comprehensive State Land Use Plan.

In Section 3 land use inventories for 1938 and 1952 are presented. These surveys were prepared by the Department in order to establish a perspective of past land use and its changes. Their compatibility with more recent maps will assist planners in analyzing factors inducing land use conversion from less intensive to more intensive uses due to urbanization.

Section 4 presents a brief summary of opportunities for applying land use inventories to planning and information requirements for such applications. The compatability of legends for each inventory is discussed. Several Appendices to this report include definitions of the various land use classifications schemes. The USGS classification scheme, designed for nationwide use with remotely sensed data and currently undergoing evaluation and revision, is included along with recent recommendations for modification.

GENERAL COMMENTS AND CONSIDERATIONS

The land use inventories in Maryland represent an application of advanced technologies to the land use planning process. Through a research program sponsored by the National Aeronautics and Space Administration, the Department of State Planning has participated in studies on the application of satellite imagery and high altitude aerial photography as data sources for land planning within the State of Maryland. The results of these programs have had a strong influence on the design and character of the Maryland land use inventories.

When using relatively small scale data sources, such as high altitude aerial photography or photo indices, land use or land cover information is best described as the graphic portrayal of the spatial distribution of landscape characteristics. The nature of the land use information collected is primarily dependent upon the classification scheme employed. By design such a scheme can focus upon portions of the landscape dominated by either natural or cultural systems, and may be further oriented to discriminate between activities, variations in land use intensity, functions, degrees of environmental quality, or other characteristics of the landscape complex.

To a large extent the specific nature of any land use inventory scheme reflects the character of the region and is dependent upon the mix of landscape components. Some amount of bias, however, always exists in the use of a classification scheme which may result from academic and professional training in specific disciplines (e.g., geography, forestry, agronomy) or from a need to emphasize certain inherent landscape characteristics.

A detailed discussion on the value of remote sensing techniques (particularly high altitude aerial photography) to land use planning and management programs is beyond the scope of this report. Some specific points, however, warrant mention. These include:

1. Aerial photo interpretation techniques are generally the least costly method of data collection.
2. Collected data are presented in a unique format, which can be spatially, temporally, and statistically more valid than traditional survey techniques.
3. By using an optimum mix of scale, resolution, and data handling techniques a system can be designed to gather either temporally constant (single time period) or continuous (over a defined time period) data.

In any management or planning situation, there will be a "most" useful data collection and information presentation scale. Although many applications can be served by the scale and detailed character of the existing maps described in this report, some anticipated critical needs will require future acquisition of larger scale data and the production of more detailed maps. Generally, high altitude aerial photography and existing map series are suitable for State and Regional land use planning applications. Activities limited by political boundaries to single counties, sub-jurisdictions within counties or to local municipalities may at times require more detailed data and maps, since information collected at a fine order of detail for a municipality or project level planning is much different than that needed for regional or more comprehensive planning endeavors.

Rational classification schemes serve as cognitive tools by which information may be extracted from the data base (i.e., high altitude aerial photography) and recorded in graphic (map) form. A landscape is a dynamic system which has developed as a result of human activity and environmental processes. Hence, landscapes and land use patterns are both culturally and environmentally dependent. Further, the landscape exhibits a series of hierarchial characteristics which form units at various scale levels. Any classification scheme, therefore, must allow for a reasonable combination of similar units into discrete legend classes.

Some success has been achieved in matching levels in a classification hierarchy to various scales of satellite and aircraft imagery. An example is the land use scheme developed by the U. S. Geological Survey in Anderson, et. al. (1972), "A Land Use Classification Scheme for Use with Remote Sensor Data." The Maryland Department of State Planning has adopted a modified version of this legend for all of its land use inventory programs.

The USGS land use scheme was developed after a long iterative process. The authors recognize that any classification scheme can seldom subsume all land use variations, or all regional differences between uses into clearly defined classes. Problems arise in boundary delineation between transitional uses or where the heterogeneous arrangement of use types compound the problem, thus presenting the need to generalize within the areas to be classified.

The USGS scheme, therefore, was formulated to meet the following criteria:

1. The minimum level of accuracy in the interpretation of the imagery should be about 90 percent.
2. The accuracy of interpretation for the several categories should be about equal.
3. Repeatable or repetitive results should be obtainable from one interpreter to another and from one time of sensing to another.
4. The classification system should be usable or adaptable for use over an extensive area.
5. The categorization should permit vegetation and other types of land cover to be used as surrogates for activity.
6. The classification system should be suitable for use with imagery taken at different times of the year.
7. Effective use of sub-categories that can be obtained from ground surveys or from the use of larger scale or enhanced imagery should be possible.
8. Collapse of categories must be possible.
9. Comparison with land use information compiled in the past or to be collected in the future should be possible.
10. Multiple-use aspects of land use should be recognized when possible.

Since its publication and adoption by Maryland, the USGS classification scheme has undergone a continuing review and modification. The scheme as used in Maryland is presented in Section 2 and documented in full in Appendix 1. Recently proposed changes are presented in Appendix 4.

The accuracy of each land use inventory is directly related to the quality of the data sources, the scale of the aerial photography, and the scale of the mapping base. These characteristics of the several land use inventories are compared in Table 1.

It is important that potential users of these inventories understand that land use classifications based on historical and high altitude aerial photography may be ambiguous relative to ground based observations. Each map series was prepared to illustrate regional land use patterns and to recognize major differences in land resource use in an appropriate manner for State and regional land use planning purposes.

TABLE 1

A COMPARISON OF THE CHARACTERISTICS OF MARYLAND LAND USE INVENTORIES

	1938-52	1970-72	1973
Data Sources	Black/White Aerial Photo Mosaics	High altitude Color & Color Infrared Photography	High altitude Color Infrared Photography
Approximate Photo-Scale	Varies 1:62,500-1:126,720	1:100,000	1:130,000
Base Map Scale	Varies to Photo-Scale	1" = 2 mi. (1:126,720)	1" = 1 mi. (1:63,360)
Map Coverage Format	County	Planning Region	County
Classification Detail	Level II	Level II	Level III
Minimum Map Unit	Not Applicable	40 Acres	10 Acres

SECTION II:
CURRENT LAND USE INVENTORIES

INTRODUCTION

This section describes the current land use inventories of Maryland, including a regional land use map series of 1970 produced by the U. S. Geological Survey, and a more detailed county land use map series of 1973 produced for the Department of State Planning by Earth Satellite Corporation. Both inventory programs utilized high altitude aerial photography, as described in the following discussions.

1970 LAND USE INVENTORY

The 1970 Land Use Inventory of Maryland was compiled originally by the U. S. Geological Survey, Geographic Applications Program (USGS-GAP), under the CARETS Project. This project was designed to develop techniques and applications of high altitude aerial photography and satellite data to land use mapping. The Central Atlantic Regional Ecological Test Site (CARETS) served as a test area for a variety of remotely sensed data applications by NASA and the Department of the Interior. The test site extended from central Virginia to Pennsylvania and New Jersey, and included all areas of Maryland east of the Catoctin Mountains.

Under a cooperative arrangement with USGS - GAP, the Department of State Planning, in conjunction with the land use suitability analysis for the Generalized State Land Use Plan, obtained preliminary draft map manuscripts of the CARETS Land Use Inventory for the Maryland areas. The Department provided field editing assistance and used the maps in support of their NASA Grant to assess the "Application of ERTS and Other Remotely Sensed Data to Comprehensive State Land Use Planning." In addition, the CARETS maps were reviewed and evaluated for their application by local & regional government planners.

In 1972, the Land Use Inventory of Western Maryland was completed in order to have a compatible map series statewide. This inventory was produced by Earth Satellite Corporation as part of the Department's NASA grant program.

Methodology

The 1970 Land Use Inventory prepared under the Central Atlantic Regional Ecological Test Site (CARETS) Project employed aerial photo interpretation techniques for high altitude color and color infrared aerial photography. The major difference between the CARETS methodology and the later 1973 DSP sponsored effort was the use of orthophoto products by USGS-GAP. Black and white orthophoto map sheets were produced by USGS from high altitude color infrared aerial photographs at a 1:100,000 scale, each sheet covering an approximate 18 mi. x 18 mi. area. Interpreted land use information was prepared on overlays to these orthophoto map bases.

The resultant land use maps, which covered 20 of Maryland's 23 counties (Western Maryland was excluded) were subsequently converted photographically to a 1:126,720 scale (1" = 2 miles). This scale conforms to standard DSP base maps. Further, the individual CARETS maps were spliced together (mosaicked) to provide a continuous map for each of Maryland's six State Planning Regions. The map projection was unchanged; the CARETS maps are based on a Universal Transverse Mercator map projection; Maryland State map products are commonly based on a Lambert Conformal Conic map projection.

Figure 1 is an example of the 1970 USGS-CARETS land use inventory in Maryland. The photograph is a black and white rendition reproduced from color infrared photography. The scale of the original photographs were 1:100,000; the portion of a scene in Figure 1 is 1:126,720 (1 inch = 2 miles). The map at right is a portion of the Level II land use interpretation corresponding to the photograph.

In order to complete a compatible statewide land use inventory, Earth Satellite Corporation compiled the Western Maryland Land Use Map in 1972. This addition was also produced from high altitude aerial photography. Land use categories were plotted on a 1:126,720 scale base map (Lambert conformal conic map projection) using standard data transfer techniques. The available photographic data included uncontrolled black and white aerial photography and air photo mosaics; the accuracy of mapped classes and boundaries reflects the quality of the available data. Plainmetric precision can not be assured for this map addition. The products have proven to be reasonably accurate and the lack of strict control does not deter from the map's value as a planning resource document.

Because available photographic data for Western Maryland varied by date from 1962 to 1971, the land use interpretations were immediately updated to 1972 for all three counties using 70mm color infrared photography of approximately 1:450,000 scale, acquired by NASA in April and June, 1972. The classification scheme employed in the Western Maryland Land Use Map was identical to the CARETS maps.

Data Sources

The aerial photographic data used for the CARETS 1970 land use maps were acquired by a NASA RB-57F aircraft and included the photography listed in Table 2. The aerial photographic data used for the Western Maryland Use Map is listed in Table 3.

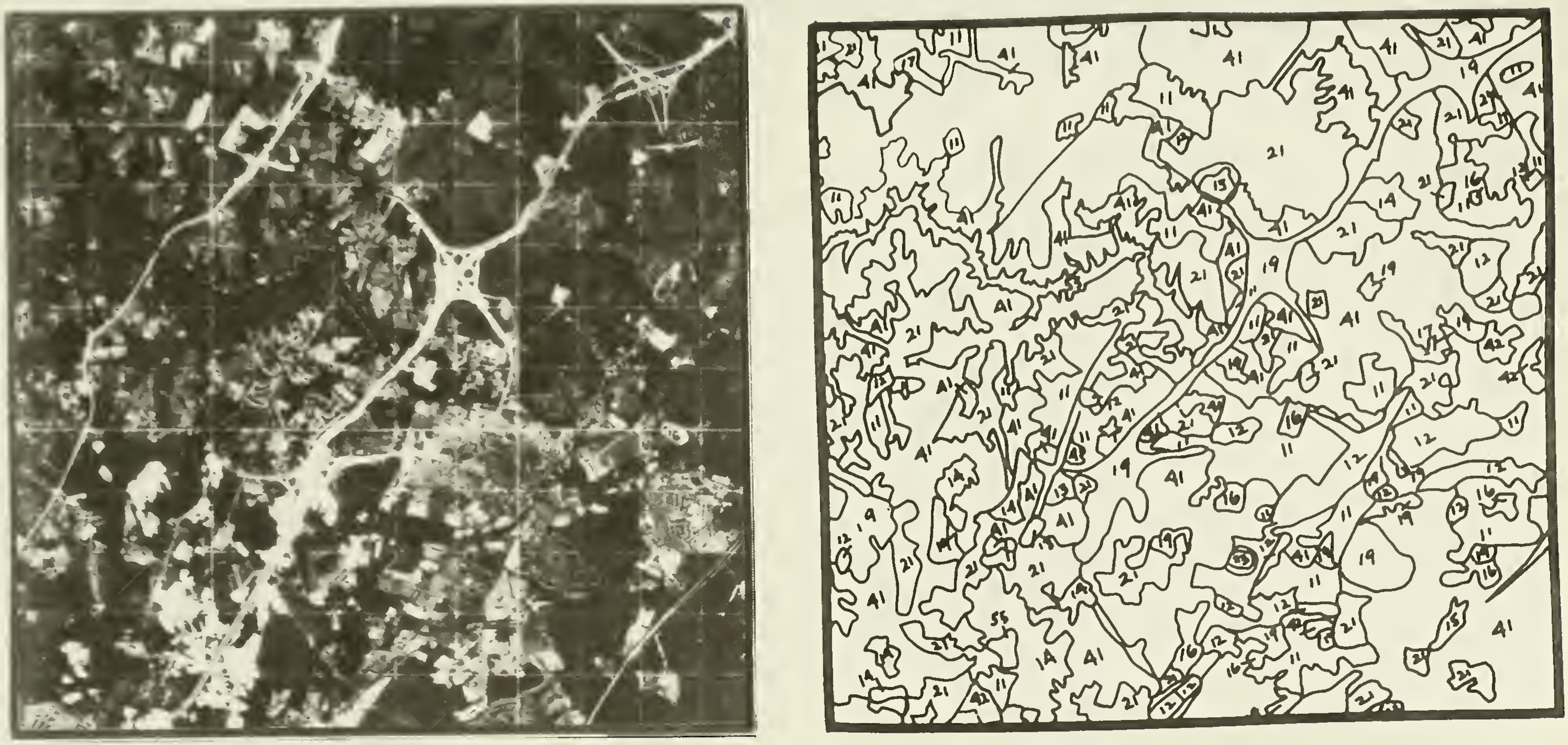
The 1970-72 Classification Scheme

The 1970-72 Maryland Land Use Maps are based on a classification scheme developed by the U. S. Geological Survey in 1971. The scheme differs from other land use schemes which are often used by planners, such as the Standard Industrial Classification (SIC), in that it graphically describes landscapes by referring to land use cover rather than to economic characteristics of land use. For example, forest lands in the USGS scheme were originally sub-divided by crown densities, and on recent revisions by leaf habit (i.e., deciduous, evergreen, etc.), rather than by economic activities such as timber production. Marsh areas in a natural state are described in the USGS scheme as a particular type of wetlands rather than in terms of their characteristic economic uses though they might be undeveloped.

In order to be applicable for use with a variety of present and future data sources and mapping scales, the USGS classification scheme uses a hierarchical structure to accommodate information at several levels of resolution or scale. The assumption is that different levels of classification would be necessary for different data sources. The seven Level I categories were conceived to be complimentary to satellite data, such as ERTS imagery. Level II categories were designed for use with high altitude aerial photography.

Each Level I category expands into two or more Level II categories by the addition of a second digit in the numerical legend code. The hierarchial organization of the numerical legend enables further expansion to a Level III, for example, even though these cateogires were not included in the original scheme. The USGS classification system also allows generalization of land use

1970 LAND USE INVENTORY



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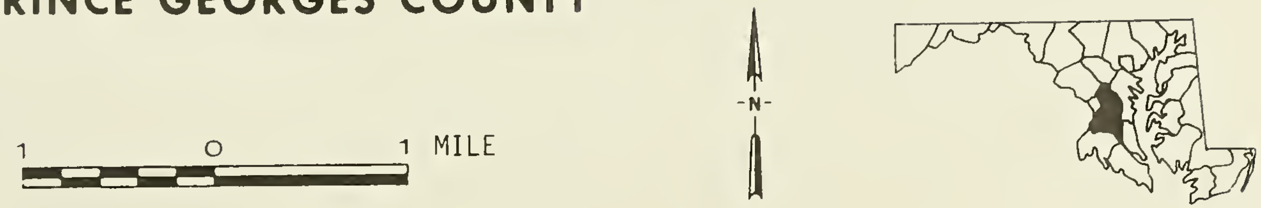


FIGURE 1

TABLE 2

USGS-CARETS 1970 LAND USE INVENTORY

Aerial Photographic Data Sources

Film Type	Camera	Focal Length	Film Format	Approx. Scale
Color	RC-8	6"	9" x 9"	1:120,000
Color IR	RC-8	6"	9" x 9"	1:120,000
Color IR	Zeiss	12"	6" x 6"	1:60,000
Color	Hasselblad	40mm	70 x 70mm	1:420,000
Color IR	Hasselblad	40mm	70 x 70mm	1:420,000
B/W Multiband	Hasselblad	40mm	70 x 70mm	1:420,000

TABLE 3

WESTERN MARYLAND 1970 LAND USE INVENTORY

AVAILABLE DATA SOURCES

* WASHINGTON COUNTY:	USDA UNCONTROLLED PHOTO-MOSAICS, B&W, APPROX. 1:63,360. 1970 USGS B&W PHOTOGRAPHY, APPROX. 1:80,000 1970.
* ALLEGANY COUNTY:	USDA UNCONTROLLED PHOTO-MOSAICS, B&W APPROX. 1:63,360, 1962.
* GARRETT COUNTY:	USDA UNCONTROLLED PHOTO-MOSAICS, B&W APPROX. 1:63,360, 1962.

DATA COMPILATION SCALE -- 1:63,360 (UNCONTROLLED)

* NASA DATA USED FOR UPDATING TO 1972

° 70mm MULTISPECTRAL PHOTOGRAPHY (APPROX. SCALE 1:450,000) ACQUIRED BY NASA U-2 AIRCRAFT FROM 65,000 FT. ALT.

° FLT. 72-067	APRIL 4, 1972
° FLT. 72-094	JUNE 7, 1972

data through the process of aggregation. Level II data categories such as "residential" and "commercial" could be combined at the first digit to become the Level I category "urban".

The USGS land use categories, along with the Level I and Level II relationships, are shown on Table 4. Maryland DSP has adopted a modified and expanded version of this scheme which was designed to meet particular land use data requirements. The 1970-72 land use maps of Maryland consist of Level II categories which occur within the State. Descriptions of each category are included in Appendix 1.

Mapping Units

Maps are characterized not only by their legends, but also by the scale and area units which are employed to display the data. The implications of this are obvious to those familiar with cartographic representation of spatial data: boundary lines dividing two categories of data are specific in their location relative to the data source and map scale; similarly, the spatial extent of data may be cartographically represented relative to the scale of the data source and map scale.

As noted, the 1970 CARETS land use maps were originally compiled at a scale of 1:100,000 and the 1972 Western Maryland Map at a scale of 1:126,720. The minimum mapping unit for land use categories in both surveys was 40 acres.

1973 LAND USE INVENTORY

Following the evaluation of the CARETS 1970 Land Use maps and the 1972 Western Maryland Land Use map by State and regional planners, Earth Satellite Corporation conducted a series of experiments to test the utility of high

TABLE 4

USGS LAND USE CLASSIFICATION SCHEME

1970 CARETS INVENTORY

Level I	Level II
10. Urban and Built-Up Land.	11. Residential
	12. Commercial and services
	13. Industrial
	14. Extractive
	15. Transportation, Communications, and Utilities
	16. Institutional
	17. Strip and Clustered Settlement
	18. Mixed
	19. Open and Other
20. Agricultural Land.	21. Cropland and Pasture
	22. Orchards, Groves, Bush Fruits, Vineyards, and Horticultural Areas
	23. Feeding Operations
	24. Other
30. Rangeland.	31. Grass
	32. Savannas (Palmetto Prairies)
	33. Chaparral
	34. Desert Shrub
40. Forest Land.**	41. Heavy Crown Cover (40% and over)
	42. Light Crown Cover (10% and over)
	43. Shrub
50. Water	51. Streams and Waterways
	52. Lakes
	53. Reservoirs
	54. Bays and Estuaries
	55. Other
60. Nonforested Wetland.	61. Vegetated
	62. Bare
70. Barren Land.	71. Salt Flats
	72. Beaches
	73. Sand Other Than Beaches
	74. Bare Exposed Rock
	75. Other

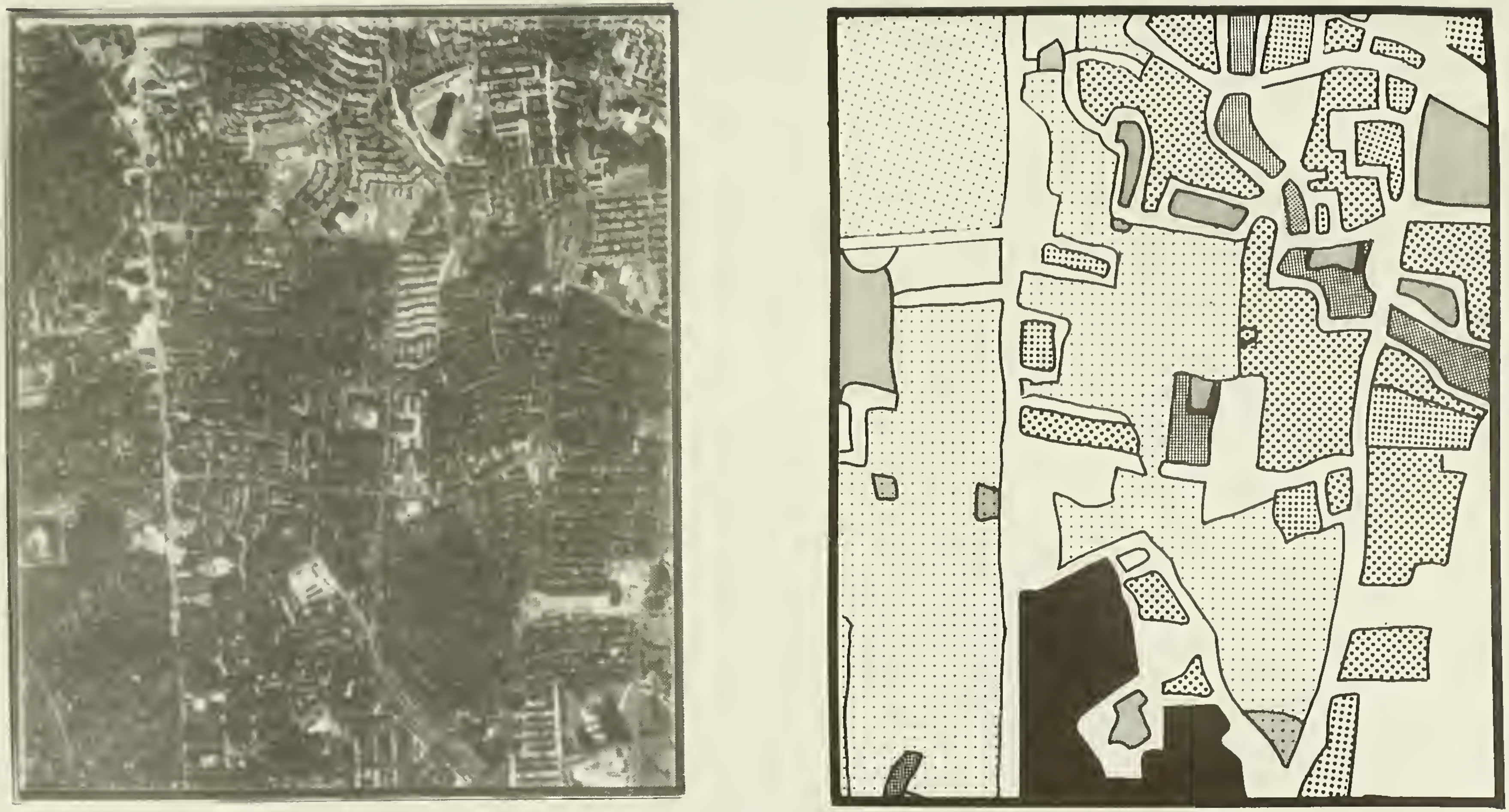
altitude aerial photography as a source of more detailed land use data. These experiments were carried out in the Spring of 1973, under the Department's program with NASA. Several areas, including Deep Creek Reservoir and vicinity in Garrett County, Ocean City and vicinity in Worcester County, Baltimore City, and the Bowie - Laurel area in Prince George's County, were studied. It was determined possible to increase detail within the classification scheme, by mapping smaller areal units, while using a larger scale, such as 1 inch equals 1 mile, than had been employed for the 1970-1972 Land Use maps.

A variety of techniques and procedures were considered and evaluated in terms of both accuracy and cost effectiveness. Maryland is unique in the fact that multiple aircraft flights were conducted over the State by NASA in 1972 and 1973, thereby providing multi-date photography for temporal analysis.

One of the areas evaluated was the dense urban environment of Baltimore City, shown in Figure 2. Only a small section was analyzed in detail; this, however, was sufficient to demonstrate the level of detail and accuracy of land use data that could be interpreted from aerial photography in an inter-urban area. The Figure includes a portion of a high altitude aerial photograph, reproduced in black and white from the original color infrared, and the corresponding land use map.

Concurrent with these evaluations, the Department considered a variety of recommendations for classification scheme refinement and evaluated the land use data needs for the preparation of the Comprehensive State Land Use Plan. State Planning staff and EarthSat photo-interpreters worked closely during this period of review and evaluation in order to develop the most

NORTH BALTIMORE CITY,1972



RESIDENTIAL AREAS

1: 26,000

FIGURE 2

desirable and cost-effective land use map products. The conclusions and recommendations included the following:

- Increase the map scale
- Add more "urban land use" detail
- Include reference points (cultural data) for map interpretation
- Increase detail (20 acre minimum)
- Include linear transportation features

Methodology

The 1973 Land Use Inventory was based almost exclusively on photo-interpretation of high altitude aerial photography acquired by NASA. Use of collateral data was minimized in order to conserve cost and time without significantly impacting accuracy and quality. Ground control was based on existing State maps of 1:63,360 scale. This scale was selected because of its compatibility with other resource and planning materials used in the State.

Collateral data sources consisted primarily of Maryland Department of Transportation County highway maps at 1:63,360 scale. Significant amounts of point cultural information is contained on these documents in addition to the boundaries of airports, military reservations and large public holdings. By serving as base maps, they provided planimetric control for the photo-interpretation processes.

Other collateral data included vegetation maps obtained from the Maryland and U. S. Forest Services, (1952, 1:63,360) which indicated major plant communities. These maps were of limited value, however, because of extensive differences noted between the 1952 maps compiled from field surveys and the 1973 aerial photography data. Differences often included both boundaries of forested areas as well as vegetation type within forest stands. USGS topographic maps were also available for collateral reference when needed by the photo-interpreter.

Data Sources

Aerial photography used in the 1973 Land Use Inventory consisted entirely of high altitude color infrared images acquired by NASA. One 1972 flight (acquired December 3) was used because of its superior quality. Multi-date coverage existed over several seasons and was used extensively, particularly for the detailed determination of vegetated land covers, including the agriculture, forest, and wetland categories. The photographic missions included those shown in Table 5.

For every area within the State, one frame of aerial photography was selected for photo enlargement on chronoflex material. Autumn and winter scenes were preferred, where possible, because of greater contrast among forest and agricultural categories during those seasons. There were over 100 selected scenes, for which black and white contact negatives were made from the color infrared transparencies and subsequently enlarged on chronoflex to a best match fit scale of 1:63,360. The resulting enlargements provided an uncontrolled base from which land use data were extracted. Original color infrared scenes of the area for several dates were also available for use. Land use boundaries and categories were plotted on overlays to these enlargements.

Because the interpretation overlays contained ground control points extracted from the base maps using highways and similar features, and because the uncontrolled aerial photo-enlargements exhibited characteristic geometric

TABLE 5

1973 LAND USE INVENTORY

Aerial Photographic Data Sources

DATE	MISSION	APPROX. SCALE	FILM TYPE
December 3, 1972	72-209	1:130,000	Color IR
January 26, 1973	73-010	"	"
January 31, 1973	73-014C	"	"
April 29, 1973	73-064B	"	"
June 1, 1973	73-084	"	"
October 27, 1973	73-1811	"	"

distortions, it was necessary to "float" the overlays to obtain a best fit. As a result, the location accuracy of land use features is relative to the location accuracies of the county base maps and maximum accuracy is found in built-up areas. This technique was selected because of the prohibitive costs involved in producing planimetric orthophoto maps. Resulting location errors are considered minimal and have not in practice deterred from the application of any map.

Classification Scheme

Land use categories on the 1973 inventory maps reflect modifications which expand and refine the USGS classification scheme. While this scheme is compatible with the USGS scheme at Level II, the Level III categories better meet Maryland State and Regional planning requirements. These categories are shown in Table 6; definitions for the categories are included in Appendix II.

TABLE 6

LAND USE CLASSIFICATION SCHEME

1973 LAND USE INVENTORY

- 110--Residential
  - 111A--Single unit residential, Low SUR Density*
  - 111B--Single unit residential, Medium SUR Density*
  - 111C--Single unit residential, High SUR Density*
  - 112A--Multi-unit Residential--Low MUR Density*
  - 112B--Multi-unit Residential--High MUR Density*
  - 113 --Mobile Home and Trailer Parks
- 120--Retail and wholesale services
  - 121--Retail sales and services (commercial)
  - 122--Wholesale and services and light industries
- 130--Industrial
  - 131--Heavy Industries--heat processing
  - 132--Heavy Industries--metal processing
  - 133--Heavy Industries--chemical processing
- 140--Extraction
  - 141--Coal (surfaces mines)
  - 142--Other quarries and pits
- 150--Transportation Communications and Utilities
  - 151--Airports and associated areas
  - 152--Railroads, including yards and terminals
  - 153--Freeways, highways, etc.
  - 154--Marine terminals
  - 155--Utilities
- 160--Educational
  - 161--Elementary Schools
  - 162--Secondary Schools
  - 163--College and University
  - 164--Military Facilities
  - 165--Other Institutional
- 170--Strip and clustered
- 190--Open and other (Urban)
- 210--Crop and Pasture land
  - 211--Crop land
  - 212--Pasture lands
- 220--Orchards
- 230--Feeding Operations
- 410--Deciduous Forest
  - 411--Upland Deciduous Forest
  - 412--Lowland Deciduous Forest
- 420--Evergreen Forest
  - 421--Upland Evergreen Forest
  - 422--Lowland Evergreen Forest
- 430--Mixed Forest
  - 431--Upland Mixed Forest
  - 432--Lowland Mixed Forest
- 440--Upland brush
- 510--Rivers
- 530--Reservoirs
- 540--Bays and Estuaries
- 600--Wetlands
  - 610--Non-Forested Vegetated Wetlands
  - 620--Non-Vegetated Wetlands
  - 630--Forested Wetlands
- 720--Beaches
- 740--Bare exposed rock

* Residential Density Data

111A - 10 du's/10 acre area
111B - 11-30 du's/10 acre area
111C - 31 or more du's/10 acre area
112A - structures less than 3 or 4 levels
112B - structures greater than 3 or 4 levels

TABLE 7

INTERPRETATION DECISION RULES FOR THE 1973 LAND USE INVENTORY

1. Categories 411 and 412, 421 and 422, 431 and 432, which as Level III distinguish Upland vs. Lowland for Deciduous, Conifers, and Mixed Forest respectively, may be presented as Level II (410, 420, 430) when, and only when, the Upland vs. Lowland distinction cannot be reasonably and unambiguously interpreted and mapped from the aerial photography.

2. Wherever feasible, residential areas shall be classified by type and density, as follows:

    111 - Single Unit Residential

        A - Low density (10 or less du's/10 acre area)

        B - Medium density (11-30 du's/10 acre area)

        C - High density (31 or more du's/10 acre area)

    112 - Multi-unit Residential

        A - Low Density (structures less than 3 or 4 levels)

        B - High Density (structures greater than 3 or 4 levels)

3. Categories 121 and 122 may be presented as 120 when Level III identification cannot be unambiguously made directly from the photos or collateral data.

4. Categories 131, 132, & 133 may be presented as 130 when Level III identification cannot be unambiguously made from the photos or collateral data.

5. Category 155 occurance will be complete only as identifiable on photos or collateral data.

6. Categories 161, 162, 163, 164, and 165 will be complete at Level III only as identifiable on photos or collateral data.

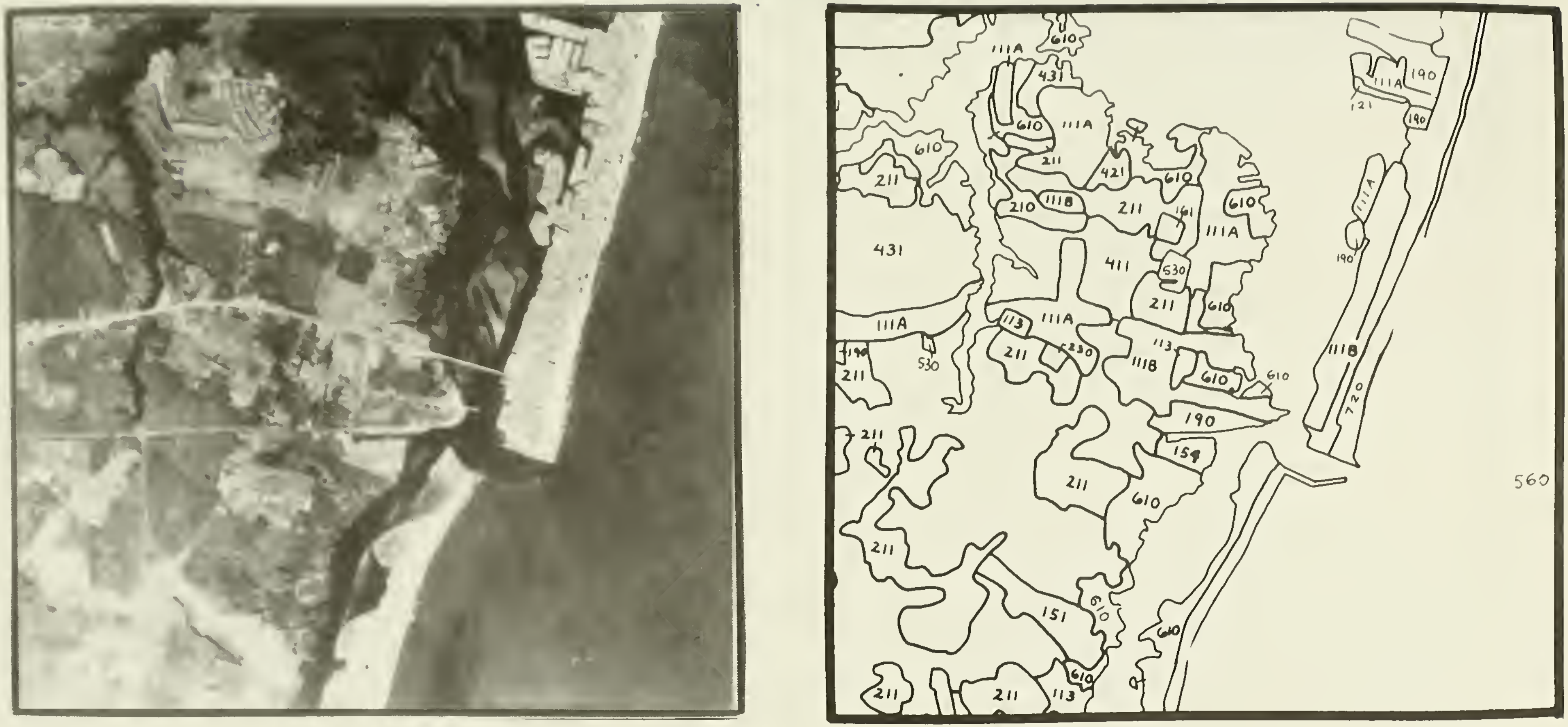
In order to implement the classification scheme for use with high altitude aerial photography and to minimize selective use of collateral data, a number of "Interpretation Decision Rules" were developed, shown in Table 7. These rules were designed to clarify ambiguous classification questions, minimize classification error, and determine when collateral data had precedence over photography. An example would include the following: if the photo-interpreter could not unambiguously determine that an agricultural area was "cropland" as opposed to "pasture", which are two unique Level III categories, then a decision rule required him to classify the area at the Level II class of "cropland and pasture." Decision rules were applied with discretion to minimize their use.

Mapping Units

As noted, the 1973 Maryland Land Use Maps were compiled by county at a scale of 1:63,360. The minimum mapping unit was 10 acres, which is approximately one-tenth inch at map scale. Units less than 530 feet wide were generally not shown, except as acute corners of larger types or as extremely elongated cultural features where the 10 acre minimum specification also applied. Because of the latter, some freeways (a transportation category) often appear on the maps only as segments which are not mapped when their width became considerably less than the minimum specification. In many cases, land use features considerably smaller than 10 acres were observed and mapped due to the high contrast between these features and their surrounding area on the aerial photographs.

Figure 3 illustrates an example of the 1973 land use inventories, prepared for each of Maryland's twenty-three counties and Baltimore City. The aerial photograph, reproduced in black and white from the original color infrared, is only one of the several seasonal images acquired in 1973 for all areas in Maryland. Multi-date photography, of high quality to enable enlargement, provides the information source for the 1 inch = 1 mile map series. The corresponding maps were prepared in a form for diazo reproduction to facilitate their distribution to a wide community of potential users in the most economical manner available.

1973 LAND USE INVENTORY



SOURCE-WORCESTER COUNTY: OCEAN CITY

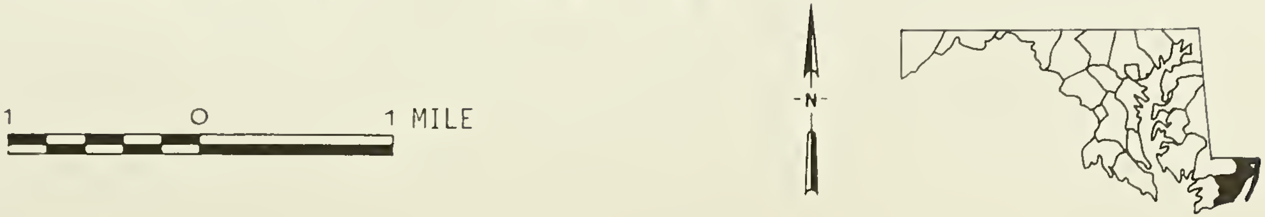


FIGURE 3

SECTION III:
1938 - 1952 TEMPORAL LAND USE SURVEY

INTRODUCTION

The 1938-1952 Temporal Land Use Survey was prepared as part of the Maryland General Land Use Plan. The emphasis of this inventory was to establish an historic perspective of land use and its changes between 1938, 1952, 1970 and 1973, in order to assist in the identification of the basic factors inducing use change and to identify pressure for land conversion.

The 1938 and 1952 Land Use Inventories are based on interpretation of aerial photo-mosaics acquired by the U. S. Department of Agriculture and obtained by the Department of State Planning from the National Archives and the Agricultural Stabilization and Conservation Service. Because of the quality of these historic documents it was not possible to use the same legend as the 1972 or 1973 Inventories. However, it was possible to employ a more general legend which enabled land use comparisons of these data for the State of Maryland.

METHODOLOGIES

Both the 1938 and 1952 Land Use Inventories were compiled through photo-interpretation of historical photo-mosaics. Level use categories were transferred directly to overlays from the photobases, by county, and therefore reflect the varying scales and geometric distortions characteristic of these documents. The approximate map scales, however, are 1" = 1 mile to 1" = 2 miles.

Use of collateral data was particularly important in compiling these maps because of the generally substandard quality of the historical photo-mosaics. Even collateral data was often limited for these historic periods. The reference materials principally used included Maryland County Highway maps and the Maryland Geological Survey's county topographic maps, each of which contain extensive cultural data.

DATA SOURCES

The U. S. Department of Agriculture established in the early 1930's a nation-wide program to acquire aerial photography of agricultural, range, and forest areas. These programs have continued through the present, operated by the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, (ASCS) with county flights scheduled every 8-10 years.

The first aerial photographic surveys were undertaken by the Agricultural Adjustment Administration (renamed the Agricultural Adjustment Agency in 1942), a predecessor of the ASCS. Aerial photography acquired prior to 1941 is now available only through the National Archives.

1938 AERIAL PHOTOGRAPHY

The 1938 aerial photography consisted of black and white images at 1:20,000 scale using a standard 9-1/2 x 9-1/2 negative format. Individual images were compiled to uncontrolled photo-mosaic index sheets which were used for the land use inventory. Individual frames, on 9 x 9 inch prints as well as enlargements, are also available from the National Archives at 1:20,000 scale. All photography was acquired for stereo coverage, with 60% fore lap and 20% side lap.

1952 AERIAL PHOTOGRAPHY

The 1952 aerial photography consisted of black and white images, also at 1:20,000 scale, using a standard 9-1/2 x 9-1/2 negative format. Again, individual images were compiled to uncontrolled photo-mosaic index sheets which were used for the land use inventory. Individual image prints of 9 x 9 inches 1:20,000 scale, and enlargements may be obtained from ASCS. All coverage is available instereo.

LIMITATIONS OF PHOTO INDEX SHEETS

As described above, the methodology for the historic land use inventories consisted of delineating land use boundaries on an overlay of the photo index sheets. This approach has the advantage of minimizing loss of image data resulting from reduction in resolution due to optical projection enlargement or reduction of scale. In addition, photo interpreters are required to handle only a fraction of the number of photographs that would be required using individual prints, thus resulting in considerable savings in time and cost.

There are, however, several disadvantages to this procedure. Mosaics are constructed for indexing purposes and are not controlled or plainimetrically accurate. As a result, boundaries, roads, and other landscape features often do not match on adjacent, overlapping photographs. The several photographic reproduction steps and the reduction in scale of the original images often results in loss of image detail, particularly within urban areas. And finally, the approximate scale of photo index sheets is not standardized.

Resulting land use map boundaries are accurate relative only to the map scale and data sources. The maps, however, adequately illustrate regional historic land use patterns and recognize major differences in land resources use. Users concerned with detailed, site specific land use questions should supplement the maps with additional materials, including original source photography.

THE 1938-1952 LAND USE CLASSIFICATION SCHEME

When aerial photography is relied upon as an inventory data source, it is not always possible to obtain complete compatibility with the categorization of land use obtained by enumeration and ground observation techniques of inventorying. Commonly, photo interpreters will verify interpretations with selective sample field (on-site) observations in order to maintain accuracy and reduce ambiguities.

Historic land use inventories create unique opportunities for the application of data but also unique problems in methodology as well. For example, it is obviously impossible to field check areas when both natural and man induced landscape changes have occurred. Also the quality of the data sources determines, in large part, the utility and accuracy of the inventory classification legend. In the case of the 1938 and 1952 land use inventories, the quality of the data sources precluded use of the legends used in the 1970 and 1973 inventories. But it was essential that the historic map legends be compatible with this and any future data.

The Department of State Planning carefully developed a unique classification legend for these historic inventories which, in its final form, was compatible with the historic photo index sheets and with the USGS scheme of the 1970 and expanded 1973 land use inventories. The most significant modifications occurred in the general urban and residential categories.

The 1938 and 1952 inventory legends aggregated these groups, consisted of residential, institutional, commercial and services, strip and clustered, and mixed, into two groups of (a) low intensive urban and (b) high intensive urban.

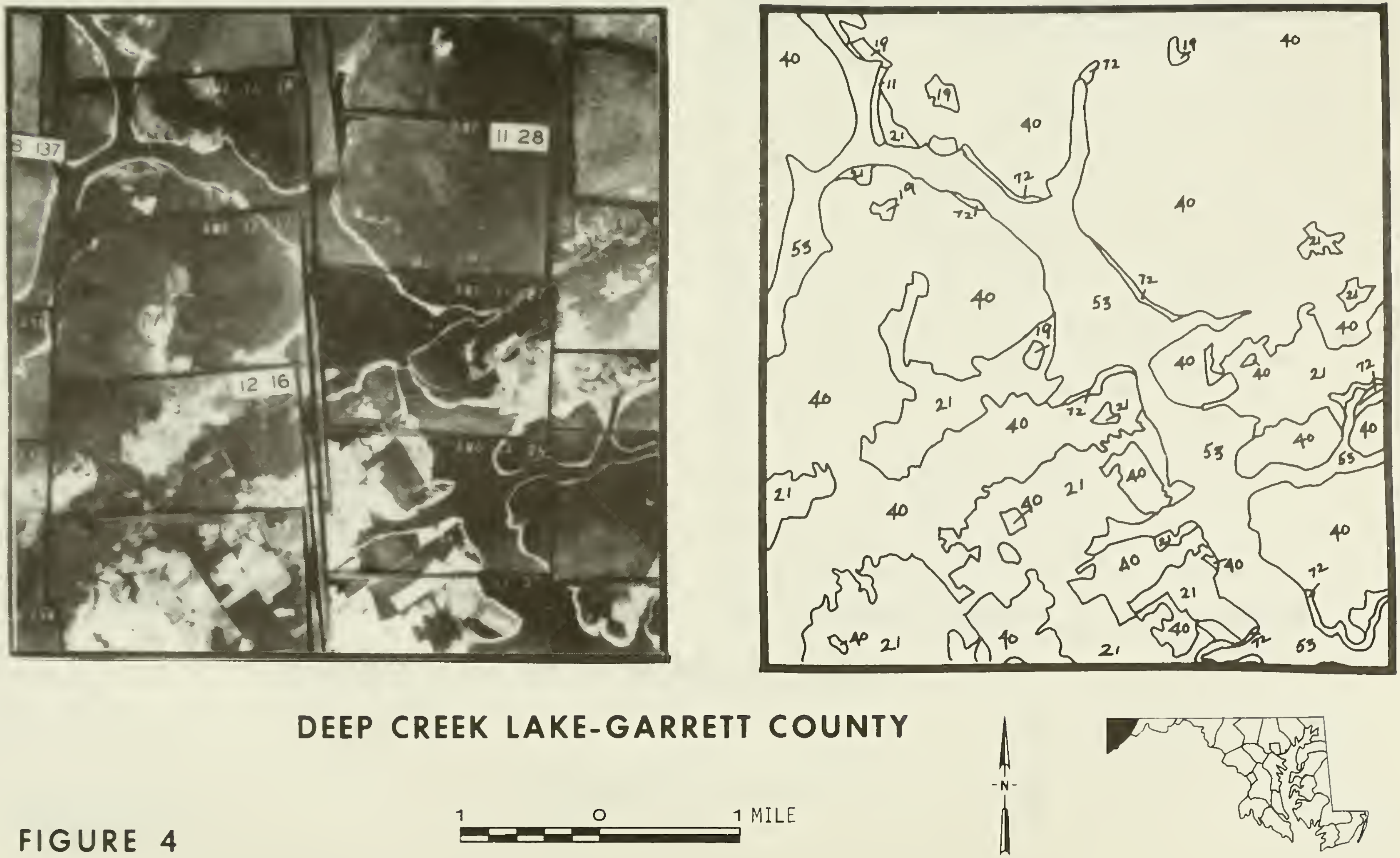
The final classification scheme used in the historic land use inventories is shown on Table 8. Definitions for each category are included in Appendix 3. Examples of the 1938 and 1952 historic land use inventories are shown in Figures 4 and 5 respectively. Figure 4 shows a portion of the 1938 photo-mosaic sheets for Garrett County and the land use interpretation map for the same area. Compared with more recent inventories, dramatic changes would be noted since the area illustrated is the vicinity of Deep Creek Reservoir prior to its construction. Figure 5, an example of the 1952 historic land use inventory, shows a photo-mosaic section and land use interpretation map of the Havre de Grace area, Harford County.

TABLE 8

LAND USE CLASSIFICATION SCHEME
1938 AND 1952 HISTORIC INVENTORIES

11	Low Intensive Urban
12	High Intensive Urban
13	Industrial
14	Extractive
15	Transportation, Communications and Utilities
19	Open & Other (Urban)
21	Cropland and Pasture
22	Orchards and Vineyards
40	Forest Cover
43	Shrub
51	Streams and Waterways
52	Lakes
53	Reservoirs
54	Bays and Estuaries
61	Vegetated Wetland
72	Beaches

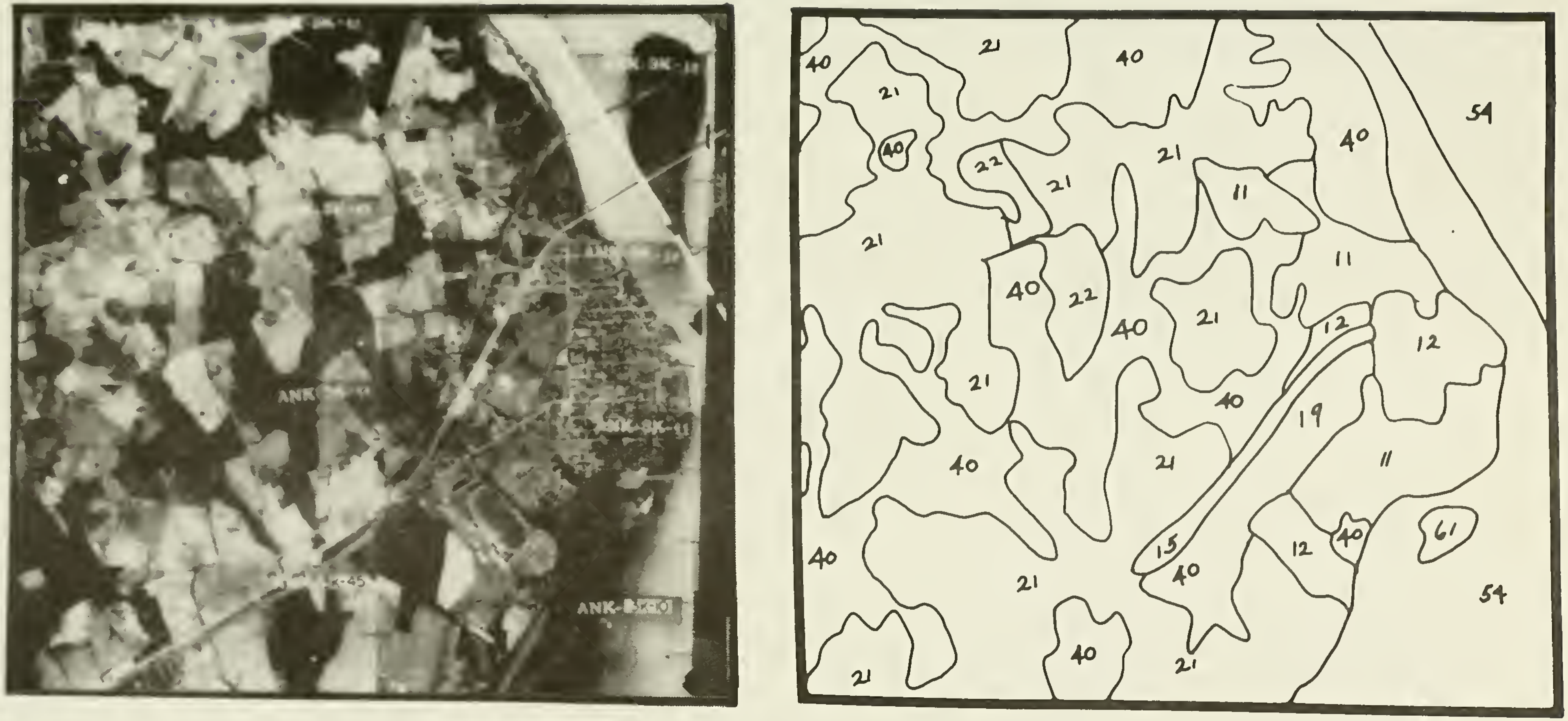
1938 LAND USE INVENTORY



DEEP CREEK LAKE-GARRETT COUNTY

FIGURE 4

1952 LAND USE INVENTORY



HARFORD COUNTY-HARVE DE GRACE

FIGURE 5

SECTION IV:
SUMMARY

INTRODUCTION

The Department of State Planning has developed a valuable land planning and land resource management tool through its compilation of a comprehensive series of historic and current land use maps. The Department has made these documents available to a wide community of users in the attempt to insure their extensive application in current and future comprehensive planning programs.

The Department is among a unique few State and Regional planning agencies that have prepared these important planning tools. The methodology used to gather this information has also been unique. Few agencies currently apply remote sensing techniques developed in recent research to operational land planning programs. The results of these technological applications will facilitate present and future land use planning processes by providing a better information base for both professional planning recommendations and legislative policy decisions.

The present series of land use maps provides an historic record of the State's land use patterns at specific points in time. Land use patterns, as these maps dramatically document, are not static, but rather continuously changing. Similarly, the Department's land use planning programs and procedures must change in order to best meet the goals established by the State Legislature in response to the changing needs of the citizens of Maryland. Maryland's Department of State Planning is determined to utilize the most advanced technology applications available to meet these goals and has several such on-going programs:

(1) the development of the Maryland Automated Geographic Information (MAGI); and

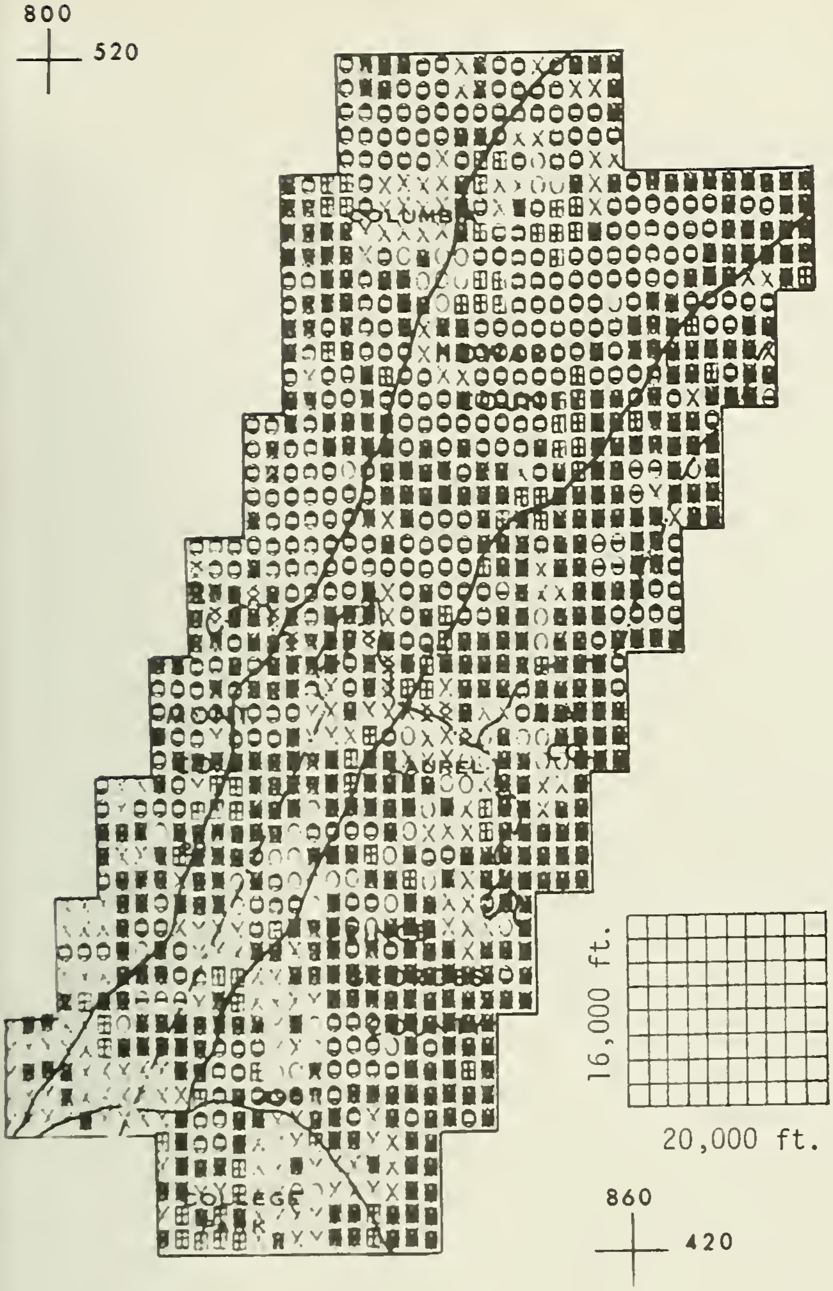
(2) continuing research involvement in the application of satellite and other remotely sensed data to comprehensive state land use planning.

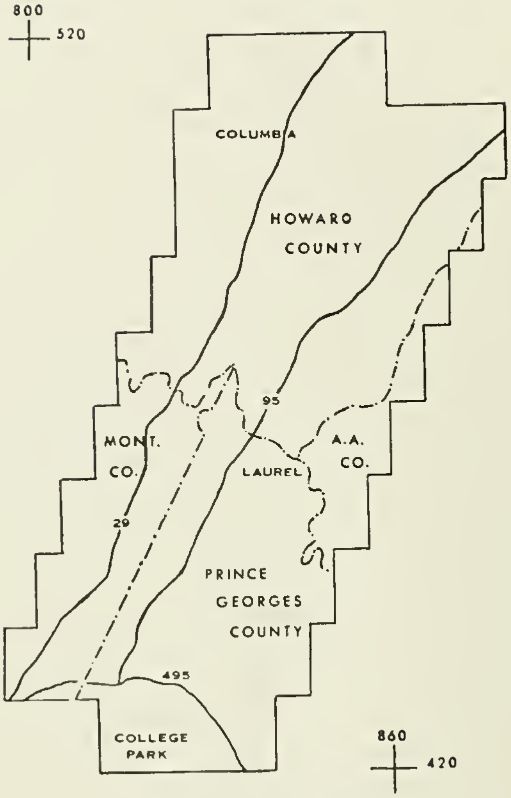
The MAGI system is an operational geographic information system containing twenty three (23) different information files on the State's natural and cultural resources. Land use maps, for example, have been digitally coded for computer analysis along with a variety of other relevant data, such as soil types, slope, sewer and water plans, publicly-owned lands, and critical areas, to name only a few. The MAGI system is fully described in DSP publication no. 207.

Figure 6 shows two data map outputs from the MAGI system. Selected 1970 land use classes in the Baltimore - Washington corridor are displayed by their primary and secondary level of dominance within a 2000 ft. x 2000 ft. grid cell area. For example, if a cell area was entirely residential, it would be displayed as such on the primary map and no data on the secondary map. If, however, the majority of the cell area were residential, but some area was also forestland, the secondary land use map would display forestland. MAGI provides rapid access and analysis of land use and planning information.

The Department's remote sensing research programs, in collaboration with Earth Satellite Corporation, are specifically focused on determining the operational capabilities of present and future information gathering systems in terms of land use and resource inventorying and monitoring.

Figure 6-a





LOCATION MAP

```
PRIMARY LAND USE: BALTIMORE-WASHINGTON CORRIDOR

MARYLAND AUTOMATED GEOGRAPHIC INFORMATION SYSTEM

MARYLAND DEPARTMENT OF STATE PLANNING - JUNE 17,1974

                              LEVEL 1 - NO DATA
                              LEVEL 2 - RESIDENTIAL: STRIP AND CLUSTERED SETTLEMENT
                              LEVEL 3 - COMMERCIAL/SERVICES: INDUSTRIAL
                              LEVEL 4 - EXTRACTIVE
                              LEVEL 5 - OTHER URBAN
                              LEVEL 6 - AGRICULTURE
                              LEVEL 7 - FOREST
                              LEVEL 8 - WATER
                              LEVEL 9 - WETLANDS/BEACHES

DATA MAPPED IN 9 LEVELS BETWEEN EXTREME VALUES OF        .50 AND       9.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
 MINIMUM              .50      1.50      2.50      3.50      4.50      5.50      6.50      7.50      8.50
 MAXIMUM             1.50      2.50      3.50      4.50      5.50      6.50      7.50      8.50      9.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
                    11.11     11.11     11.11     11.11     11.11     11.11     11.11     11.11     11.11

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL                                        HIGH VALUES
           LOW VALUES   1         2         3         4         5         6         7         8         9         10
LEVELS      ==========================================================================================================
                    .........  '''''''''           ---------  IIIIIIII  OOOOOOOOO  ■■■■■■■■■  000000000  +++++++++
                    .........  '''''''''           ---------  IIIIIIII  OOOOOOOOO  ■■■■■■■■■  000000000  +++++++++
SYMBOLS             .... ....  '''' ''''           ---- ----  IIII III  OOOO OOOO  ■■■■ ■■■■  0000 0000  ++++ ++++
                    .........  '''''''''           ---------  IIIIIIII  OOOOOOOOO  ■■■■■■■■■  000000000  +++++++++
                    .........  '''''''''           ---------  IIIIIIII  OOOOOOOOO  ■■■■■■■■■  000000000  +++++++++
            ==========================================================================================================
FREQ.      [illegible]                                                                           11         0         0
```

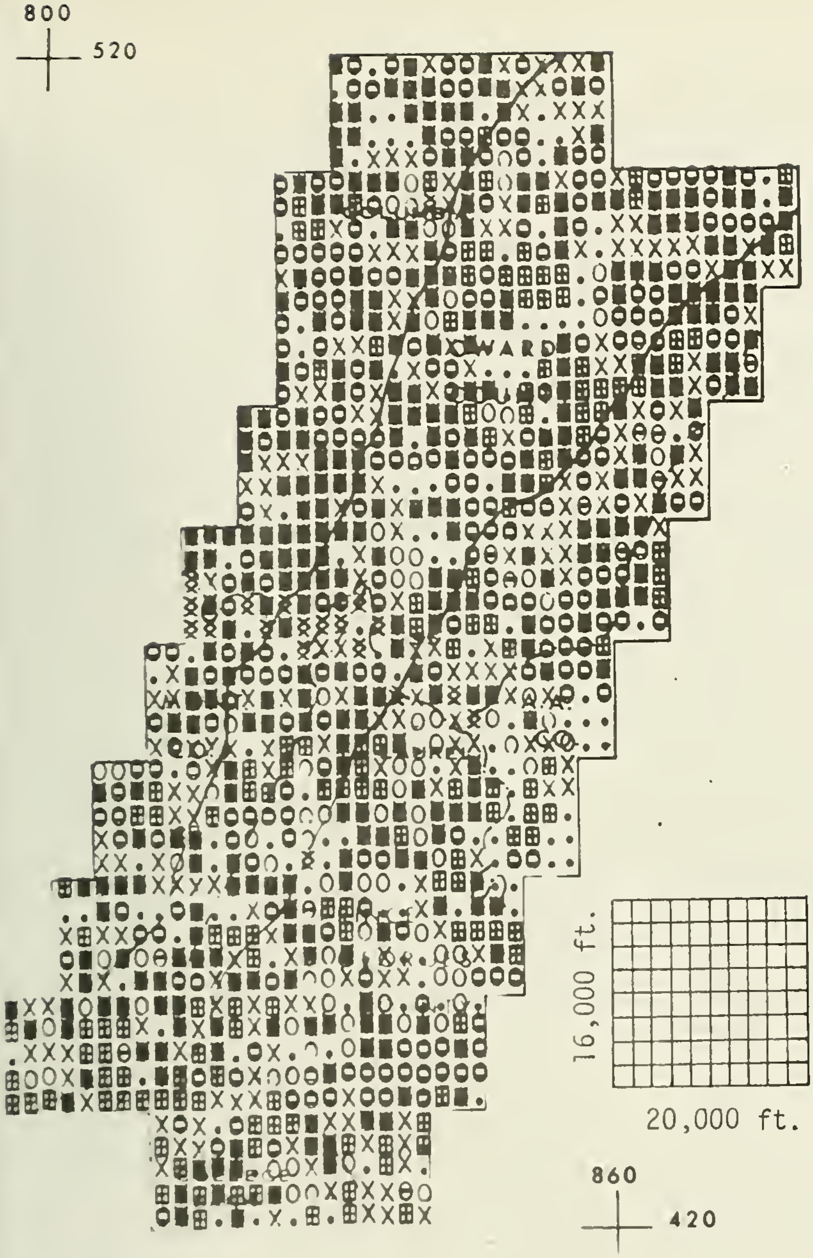
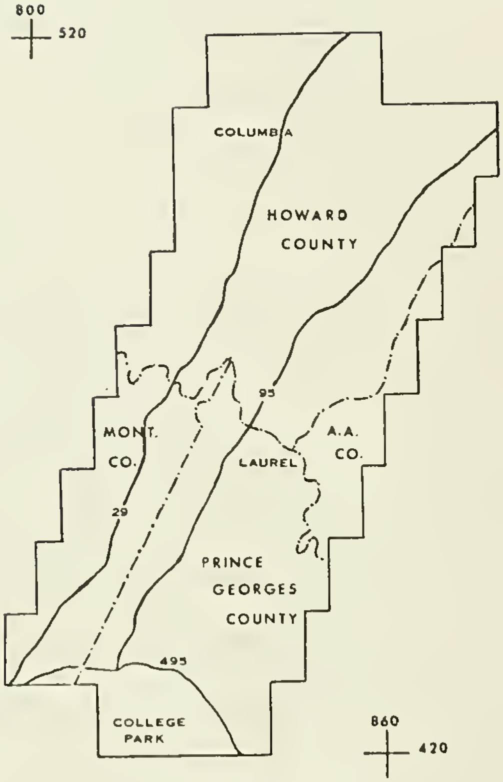


Figure 6-b



LOCATION MAP

```
SECONDARY LAND USE: BALTIMORE-WASHINGTON CORRIDOR

MARYLAND AUTOMATED GEOGRAPHIC INFORMATION SYSTEM

MARYLAND DEPARTMENT OF STATE PLANNING - JUNE 13,1974


                         LEVEL 1 - NO DATA
                         LEVEL 2 - RESIDENTIAL; STRIP AND CLUSTERED SETTLEMENT
                         LEVEL 3 - COMMERCIAL/SERVICES; INDUSTRIAL
                         LEVEL 4 - EXTRACTIVE
                         LEVEL 5 - OTHER URBAN
                         LEVEL 6 - AGRICULTURE
                         LEVEL 7 - FOREST
                         LEVEL 8 - WATER
                         LEVEL 9 - WETLANDS/BEACHES


DATA MAPPED IN  9 LEVELS BETWEEN EXTREME VALUES OF        .50 AND.     9.50


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
 MINIMUM              .50      1.50      2.50      3.50      4.50      5.50      6.50      7.50      8.50
 MAXIMUM             1.50      2.50      3.50      4.50      5.50      6.50      7.50      8.50      9.50


PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
                    11.11     11.11     11.11     11.11     11.11     11.11     11.11     11.11     11.11


FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL                                            HIGH VALUES
          LOW VALUES                                                                                     10
LEVELS         0          1         2         3         4         5         6         7         8         9
          =========================================================================================================
                      .........  /////////  000000000  AAAAAAAAA  [illegible]  000000000  ■■■■■■■■■  ØØØØØØØØØ  +++++++++
                      .........  /////////  000000000  AAAAAAAAA  [illegible]  000000000  ■■■■■■■■■  ØØØØØØØØØ  +++++++++
SYMBOLS               ....  ....  ////  ////  0000  0000  AAAA  AAAA  [illegible]  0000  0000  ■■■■  ■■■■  ØØØØ  ØØØØ  ++++  ++++
                      .........  /////////  000000000  AAAAAAAAA  [illegible]  000000000  ■■■■■■■■■  ØØØØØØØØØ  +++++++++
                      .........  /////////  000000000  AAAAAAAAA  [illegible]  000000000  ■■■■■■■■■  ØØØØØØØØØ  +++++++++
          =========================================================================================================
FREQUENCY      0        135       205        85        12       148       243       338        19         0         0
```

Presently, this program is concerned with the applications of NASA's Earth Resources Technology Satellite (ERTS-1) data, the monitoring of research results with higher resolution Skylab photography, as well as the preparation of comprehensive mapping projects using high altitude aerial photography. The results of these research programs appear in periodic Department and NASA reports and publications.

TWENTY-FIVE YEARS OF LAND USE CHANGE: AN EXAMPLE

Figure 7 illustrates the land use changes that have occurred between 1938 and 1973 in area around Columbia, Howard County. In 1938, the area was largely agricultural and woodland, with a few scattered urban settlements. Changes by 1952 were not dramatic, although urban areas had expanded in the predominatly rural environment. By 1970, the planned community of Columbia was well established, dramatically changing the character of the area. Changes in 1973 show continued growth and development of urban land uses in the Columbia area.

LAND USE SURVEY COMPATIBILITIES

To facilitate the analysis of land use patterns, the Department was careful to make the characteristics of the various historic and current land use inventories compatible whenever possible. Due to differences in both the type and quality of the aerial photograpy data bases, compatibility of certain characteristics (such as scale and minimum mapping units) was not always completely feasible. While the classification schemes are not identical, they were made compatible through the development of hierarchical categories. For example, the most detailed classification scheme (Level III) is in the 1973 Land Use Inventory, whereas the 1970-72 Land Use Inventory legend stops at Level II. Hence, the 1970 data can be compared to that of 1973 if the 1973 data is aggregated to Level II. The compatibility relationships between the 1938-1952, 1970-72, and 1973 land use inventory classification schemes are shown in Table 9. This table illustrates the correspondence among the three classification schemes of these different land use categories.

TABLE 9

COMPATIBILITY OF THE CLASSIFICATION SCHEMES FOR THE
1938 and 1952, 1970-72, and 1973 LAND USE INVENTORIES

1938-1952	1970-72	1973
11	11	110, 111A, 111B, 111C, 112A, 112B, 113
12	12	120, 121, 122
13	13	130, 131, 132, 133
14	14	140, 141, 142
15	15	150, 151, 152, 153, 154, 155
11 or 12	16	160, 161, 162, 163, 164, 165
11 or 12	17	170
11 or 12	18	
19	19	190
21	21	210, 211, 212
22	22, 23, 24	220, 230
40	40	410, 411, 412, 420, 421, 422, 430, 431, 432
43	43	440
51	51	510
52	52	520
53	53	530
54	54	540
	55	
61	60, 61, 62	630
	40	
72	71, 72, 73, 74, 75	720, 740

LAND USE CHANGE—COLUMBIA AND VICINITY

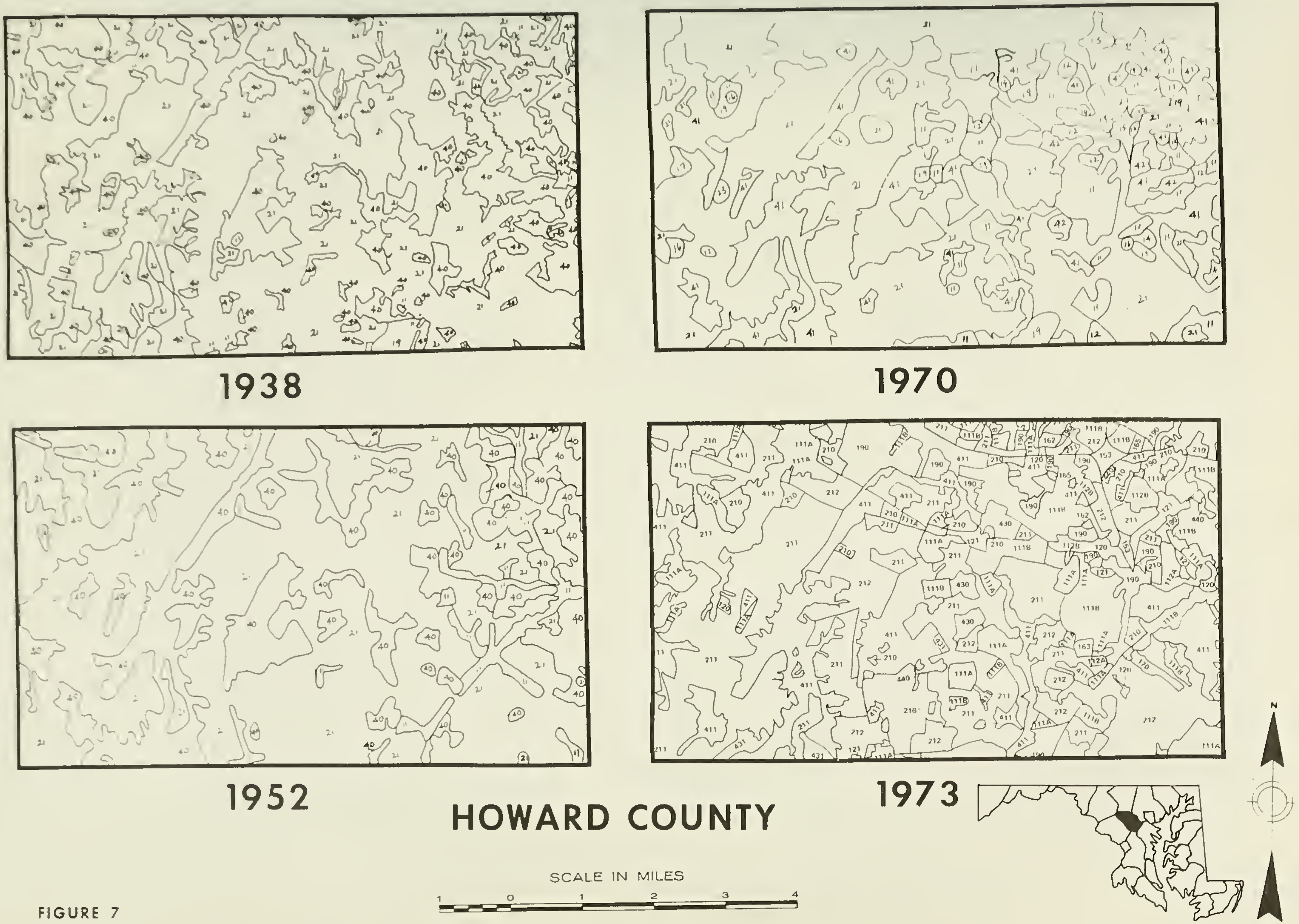


FIGURE 7

APPENDIX I:
1970 LAND USE CLASSIFICATION SCHEME DEFINITIONS

The following definitions apply to Level I and Level II of the U.S.G.S. "Land Use Classification Scheme for Use with Remote Sensor Data." The definitions are reprinted in their unabridged form from U.S.G.S. Circular 671 (1972). These definitions not only apply to the 1970-72 land use inventory of Maryland, but also form the basis from which classification legends and definitions for the 1973, 1938 and 1952 land use inventories were developed.

DEFINITIONS

In the definitions presented here, an attempt has been made to include sufficient detail to provide a general understanding of what is included in each category at Levels I and II. Many of the uses described in detail will not be visible on spacecraft and high-altitude imagery. However, the detail will aid in the interpretation process, and the additional information will be useful to those who have large-scale aerial photographs and other supplemental information available.

10. Urban and Built-Up Land

Urban and Built-up Land comprises areas of intensive use with much of the land covered by structures. Included in this category are cities, towns, villages, strip developments along highways, transportation, power, and communications facilities, and such isolated units as mills, mines, and quarries, shopping centers, and institutions.

As development progresses, small blocks of land of less intensive or nonconforming use may be isolated in the midst of built-up areas and will generally be included in the 01-category. Agricultural, forest, or water areas on the fringe of Urban and Built-up areas will not be included except where they are part of low-density urban development. The Urban and Built-up Land category takes precedence over others when the criteria for more than one category are met. Thus, residential areas that have sufficient tree cover to meet Forest Land criteria will be placed in the Residential category.

The Level II categories of Urban and Built-up Land are: Residential; Commercial and Services; Industrial; Extractive; Transportation, Communications, and Utilities; Institutions; Strip and Clustered Settlements; Mixed; and Open and Other.

11. RESIDENTIAL

Residential land uses range from high density, represented by the multiple-unit structures of urban cores, to low density, where houses are on lots of more than an acre, on the periphery of urban expansion. Linear residential developments along transportation routes extending outward from urban areas should be included as residential appendages to urban centers, but care must be taken to distinguish them from commercial strips in the same locality. The residential strips generally have a uniform size and spacing of structures, linear driveways, and lawn areas; the commercial strips are more likely to have buildings of different sizes and spacing, large driveways, and parking areas. Residential development along shorelines is also linear and sometimes extends back only one residential parcel from the shoreline to the first road.

Areas of sparse residential land use will be included under another category. In some places, the boundary will be clear where new housing developments abut against intensively used agricultural areas, but the boundary may be vague and difficult to discern when residential development is sporadic, or occurs in small isolated units over an extended period of time in areas of mixed or less intensive uses. A careful evaluation of density and the overall relation of the area to the total urban complex must be made.

Residential sections may also be included in other use categories where they are integral parts of the other use. Housing on military bases, at colleges and universities, living quarters for laborers near a work base, or lodging for employees of agricultural field operations or resorts are often difficult to identify and may be placed within the institutional, industrial, agricultural, or commercial categories.

12. COMMERCIAL AND SERVICES

Commercial areas are those used predominantly for the sale of products and services. They are often abutted by residential, agricultural, or other contrasting uses which help define them. The principal components of the Commercial-use category are urban central business districts; shopping centers, usually in suburban and outlying areas; commercial strip developments along major highways and access routes to cities; and resorts. The main buildings, secondary structures, and areas supporting the basic use are all included—office buildings, warehouses, driveways, sheds, parking lots, landscaped areas, and waste-disposal areas.

Commercial areas may include some noncommercial uses too small to be separated out. Central business districts often include some institutions, such as churches and schools, and commercial strip developments may include some residential units. These are not separated out unless they exceed one-third the total commercial area. Recreational areas are not segregated as such at Level II but may cause some problems in identification. Recreational facilities that form an integral part of an institution should be included in the Institutional category. A self-contained sports area, on the other hand, such as a stadium for professional events, is Commercial. There is usually a major visible difference in the form of parking facilities, arrangements for traffic flow, and the general association of buildings and facilities. Near a resort, the intensively developed recreational areas would be included in the Commercial category, but extensive golf courses and riding areas would be included in another category, the Open and Other, if in an urban setting. Public and private golf courses, ski and toboggan areas, and other recreational facilities are also classed as Open land.

13. INDUSTRIAL

Industrial areas include a wide array of uses from light manufacturing and industrial parks to heavy manufacturing plants. Identification of light industries—those focused on design, assembly, finishing, and packaging of products—can often be based on the type of building, parking, and shipping arrangements. Light industrial areas may be, but are not necessarily, directly in contact with urban areas; many are now found at airports or in relatively open country. Heavy industries use raw materials such as iron ore, lumber, or coal. Included are steel mills, pulp or lumber mills, electric power generating stations, oil refineries and tank farms, chemical plants and brick-making plants. Stock piles of raw materials, large power sources, and waste product disposal areas are usually visible, along with transportation facilities capable of handling heavy materials.

14. EXTRACTIVE

Extractive Land encompasses both surface and subsurface mining operations, such as sand and gravel pits, stone quarries, oil and gas wells, and metallic and nonmetallic mines. In size, these activities range from the unmistakable giant strip or pit mines covering vast areas to the unidentifiable gas wells less than a foot square. Surface structures and equipment may range from a minimum of a loading device and trucks to extended areas with access roads, processing facilities, stockpiles, equipment sheds, and numerous vehicles. Spoil material and slag heaps are usually found within a short trucking distance of the major mine areas and may be the key indicator of underground mining operations. Uniform identification of all these diverse extractive uses is extremely difficult from remote sensor data alone.

Industrial complexes where the extracted material is refined, packaged, or further processed are included in the Industrial category even if the plant is adjacent to the mine. Areas of future reserves are included in the appropriate present-use category, Agricultural or Forest Land, regardless of the expected future use. Unused pits or quarries that have been flooded are placed in the Water category if the water body is larger than 40 acres. Areas of tailings, abandoned pits and quarries, and strip-mined areas may remain barren for decades unless steps are taken to hasten the establishment of vegetation. Until vegetative cover is established, such parcels remain in the Extractive category.

15. TRANSPORTATION, COMMUNICATIONS, AND UTILITIES

Major transportation routes and areas greatly influence other land uses, and many land-use boundaries are outlined by them. The types and extent of transportation facilities in a locality determine the degree of access and affect both the present and potential use of the area.

Highways and railways are characterized by areas of activity connected in linear patterns. The highways include areas used for interchanges, limited access right-of-way, and service and terminal facilities. Rail facilities include stations, parking lots, roundhouses, repair and switching yards, and related areas, but overland track is not included unless six or more tracks are joined to give sufficient width for delineation at a scale of 1:250,000. Spur connections from an active line are included in the appropriate Industrial or Extractive category.

Airports, seaports, and major lakeports are isolated areas of high utilization, usually with no well defined intervening connections, although some water ports are connected by canals. Airport facilities include the runways, intervening land, terminals, service buildings, navigation aids, fuel storage, parking lots, and a limited buffer zone. The perimeter fence around airports usually makes a very sharp boundary that is visible on high-altitude imagery. Small airports, such as those on rotatable farm land, heliports, and land associated with seaplane bases are not included. Port areas include the docks, shipyards, drydocks, locks, and watercourse-control structures.

Communications and utilities areas involved in transport of water, gas, oil, electricity, and areas used for airwave communications are also included in this category. Pumping stations, electric substations, and areas used for radio, radar, or television antennas are the major types. Small facilities, or those associated with an industrial, commercial, or extractive land use, are included within the larger category with which they are associated. Long-distance gas, oil, electric, telephone, water, or other transmission facilities rarely constitute the dominant use of land over which they pass. If these uses are dominant and meet the minimum width criteria, they may be identified as transportation uses.

16. INSTITUTIONAL

Education, religious, health, correctional, and military facilities are the main components of this subcategory. All buildings, grounds, and parking lots that compose the facility are included within the institutional unit, but areas not specifically related to the purpose of the institution should be placed in the appropriate category. Auxiliary land uses, particularly residential, commercial and services, and other supporting land uses on a military base would be included in the Institutional subcategory, but agricultural areas not specifically associated with correctional, educational, or religious institutions are placed in the appropriate agricultural category. Small institutional units, as, for example, many churches and some secondary and elementary schools, will not meet the minimum area requirements and will be included within another category, usually Residential or Commercial. Historic forts may be confused with correctional institutions because of the similarity of buildings, but the historical sites have larger parking areas and often smaller landscaped or grass areas.

17. STRIP AND CLUSTERED SETTLEMENT

The Strip and Clustered Settlement category includes developments along transportation routes and the smaller cities, towns, and built-up areas where separate land uses may not be distinguishable. Residential, commercial, industrial, institutional, and occasionally other land uses may be included. Farmsteads intermixed with strip or cluster settlements will be included within the built-up land, but other agricultural land uses should be excluded.

18. MIXED

This category is used for a mixture of second-level urban uses in larger cities (more than 50,000 inhabitants) where no one use predominates. In any category, as much as one-third intermixture of another use is allowed without changing the basic classification, but where the intermixture is greater, where several uses, though each is less than one-third, are included, or where individual second-level units may be too small to be separated although the aggregate of such uses may be large, the Mixed category is used.

19. OPEN AND OTHER (URBAN)

Open land consists of golf courses, some parks, ski areas, cemeteries, and undeveloped land within an urban setting. Open land may be in very intensive use but a use that does not require structures. Other land includes the small blocks of less intensive or nonconforming uses that become isolated.

20. Agricultural Land

Agricultural Land may be broadly defined as land used primarily for production of farm commodities. On high-altitude imagery, the chief indications of agricultural activity will be symmetrical patterns made on the landscape by use of mechanized equipment. However, pasture and other lands where such equipment is used infrequently may not show as well-defined shapes as other areas.

Symmetrical patterns are also characteristic of Urban and Built-up Lands because of street layout and development by blocks. Distinguishing between Agricultural and Urban and Built-up Lands should ordinarily be possible on the basis of urban activity indicators and the associated concentration of population. The number of building complexes is smaller and the density of the road and highway network is much lower in Agricultural Lands than in Urban and Built-up Land. Some urban land uses, such as parks and large cemeteries, however, may be mistaken for Agricultural Land, especially when they occur on the periphery of the urban areas.

The interface of Agricultural Land with other categories of land use may sometimes be a transition zone in which there is an intermixture of land uses at first and second levels of categorization. Where farming activities are limited by wetness, the exact boundary may also be difficult to locate, and Agricultural Land may grade into swamp Forest Land, Nonforested Wetland, or Water.

The Level II categories of Agricultural Land are: Cropland and Pasture; Orchards, Groves, Vineyards, Bush Fruits, and Horticultural Areas; Feeding Operations; and Other.

21. CROPLAND AND PASTURE

The several components of Cropland and Pasture now used for agricultural statistics include: Cropland harvested; cultivated summer fallow and idle cropland; land on which crop failure occurs; cropland in soil improvement grasses and legumes, cropland used only for pasture or pasture in rotation with crops; pasture on land more or less permanently used for that purpose. From imagery alone, it is generally not possible to make a distinction between Cropland and Pasture with a high degree of accuracy and uniformity, let alone a distinction among the various components of Cropland. Moreover, some of the categories listed represent the condition of the land at the end of the growing season, and will not apply exactly to imagery taken at other times of the year. They will, however, be a guide to identification of Cropland and Pasture.

Certain factors vary throughout the United States and this variability must also be recognized; field size depends on topography, soil types, sizes of farms, kinds of crops and pastures, capital investment, labor availability and other conditions. Irrigated land in the Western States is easily recognized in contrast to Rangeland, but in the Eastern States, irrigation by use of overhead sprinklers cannot always be detected from imagery unless distinctive circular patterns are created. Drainage or water control on land used for cropland and pasture may also create a recognizable pattern that may aid in identification of the land use. In areas of quick-growing crops a field may appear to be in nonagricultural use unless the temporary nature of the inactivity is recognized.

22. ORCHARDS, GROVES, VINEYARDS, BUSH-FRUIT AND HORTICULTURAL AREAS

Orchards, groves, vineyards, and bush-fruit areas produce the various fruit, nut, and berry crops. Horticultural areas include nurseries, floricultural areas, and seed-and-sod areas used perennially for that purpose. Many of these areas may be included in another category, generally Cropland and Pasture, when identification is made by use of satellite or high-altitude imagery alone. Identification may be aided by recognition of the combination of soil qualities and climatological factors needed for these operations: water bodies in close proximity to moderate the effects of short duration temperature fluctuations; site selection for air drainage on sloping land; deep, well-drained soils on slopes moderate enough to permit use of machinery. Isolated orchards of a few acres do not constitute commercial orchards large enough to identify on high-altitude imagery, and remnants of the few acres of fruit trees on the family farm are usually not recognizable and are therefore not included.

23. FEEDING OPERATIONS

Feeding Operations are large, specialized, livestock-production enterprises, chiefly beef cattle feedlots and large poultry farms, but also including large hog and fur-bearing animal farms. These operations have large animal populations restricted to relatively small areas. The result is a concentration of waste material that is an environmental concern. The waste-disposal problems justify a separate subcategory for these relatively small areas. Feeding Operations have a built-up appearance, chiefly composed of buildings, much fencing, access paths, and waste-disposal areas. Some are located near an urban area to take advantage of transportation facilities and proximity to processing plants.

Feeding operations in conjunction with another farm enterprise are not included. Also excluded are shipping corrals and other temporary holding facilities. Game farms and zoos do not meet the animal-population densities to be placed in this subcategory.

24. OTHER AGRICULTURAL LAND

Inactive agricultural land is an important component of this subcategory. Such land has no physical indication of present agricultural use and no natural cover, such as brush, which would curtail its ready use for agriculture. Farmsteads, including holding areas for livestock, farm lanes and roads, ditches and canals, small farm ponds, and similar uses are generally quite small and often unrecognizable from high-altitude imagery so that these uses will generally be included with adjacent agricultural uses.

30. Rangeland

Rangeland may be defined as land where the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs, where natural herbivory was an important influence in its precivilization state, and that is more suitable for management by ecological rather than agronomic principles. Some rangelands have been or may be seeded to introduced or domesticated plant species. Most of the rangelands in the United States are in the Western Range, the area to the west of an irregular north-south line that cuts through the Dakotas, Nebraska, Kansas, Oklahoma, and Texas. Rangelands are also found in the Southeastern States and Alaska.

The Level II categories of Rangeland are: Grass, Savannas (Palmetto Prairies), Chaparral, and Desert Shrub.

31. GRASS

This subcategory encompasses the tall grass (or true prairie), short grass, bunch grass or palouse grass, and desert grass regions. These grass regions generally represent a sequence of declining amounts of available moisture. Most of the tall grass region has been plowed for agriculture. The bulk of the remaining tall grass range is now in North Dakota, Nebraska, southern Kansas and Oklahoma, and the Texas Coastal Plain. Short grass rangeland occurs in a strip about 300 miles wide from the Texas Panhandle northward to the Dakotas where it widens to cover the western half of the Dakotas, the eastern three-fourths of Montana, and the eastern third of Wyoming.

32. SAVANNAS (PALMETTO PRAIRIES)

The Palmetto Prairies in south-central Florida, north, west, and southwest of Lake Okeechobee consist mainly of dense medium tall grasses with scattered palms and shrubs. Many areas are now in improved pasture.

33. CHAPARRAL

This category includes California chaparral, the scrub oak or shinnery, and the mountain brush types.

34. DESERT SHRUB

Vegetation in this zone includes the creosote bush, sagebrush, greasewood, and other desert shrubs. Bottom lands and moister flats are often characterized by dense stands of mesquite, and where alkali is high, desert saltbrush dominates wide areas.

40. Forest Land

Forest lands are lands that are at least 10 percent stocked by trees capable of producing timber or other wood products that exert an influence on the climate or water regime. Forest land can generally be identified rather easily from high-altitude imagery, although the boundary between it and other classes of land may be difficult to delineate precisely.

Lands from which trees have been removed to less than 10 percent stocking but which have not been developed for other use are also included. For example, lands on which there is forest rotation, involving clear-cutting and block planting, are part of Forest Land. On such lands, when trees reach marketable size, which for pulpwood in the Southeastern United States may occur in two to three decades, there will be large areas that have little or no visible forest growth. The pattern can sometimes be identified by the presence of cutting operations in the midst of a large expanse of forest. Unless there is evidence of other use, such areas of little or no forest growth should be included in the Forest Land category. Lands that meet the requirements for Forest Land and also for a higher use category should be placed in the higher category.

At Level II, Forest Land will be divided into three categories: Deciduous, Evergreen, and Mixed. To differentiate the three, sequential imagery, or at least imagery during the period when deciduous trees are bare, will be necessary.

41. DECIDUOUS FOREST LAND

Deciduous Forest Land includes all forested areas in which the trees are predominantly those from which the leaves fall at the end of the growing period. In most parts of the United States, these would be the hardwoods, such as oak, maple, beech, ash, hickory, and aspen, and the "soft hardwoods" such as sweet gum, tupelo, cottonwood, and yellow poplar. Tropical hardwoods such as mahogany and ebony are not included as they are broad-leaved evergreens and hence are included in the Evergreen Forest Land category.

42. EVERGREEN FOREST LAND

Evergreen Forest Land includes all forested areas in which the trees are predominantly those which remain green throughout the year. Both coniferous and tropical broad-leaved evergreens are included in this category. In most areas, the coniferous evergreens predominate, but the mangrove swamps of Florida and some of the forests of Hawaii are notable exceptions. The coniferous evergreens are commonly referred to or classified as softwoods. They include such eastern species as the longleaf, slash, shortleaf, loblolly, and other southern yellow pines; spruce and balsam fir; white and red pines; jack pine; hemlock; and cypress; and such western species as Douglas-fir, ponderosa pine, redwood, Sitka spruce, Engelmann spruce, lodgepole pine, red cedar, larch, hemlock, and white pine.

43. MIXED FOREST LAND

Mixed Forest Land includes all forested areas where both evergreen and deciduous trees are growing and neither predominates.

50. Water

The Water category includes all areas within the land mass of the United States that are predominantly or persistently water covered, provided that, if linear, they are at least 1/8 mile (660 feet or 200 meters) wide and if extended cover at least 1/8 square mile or 40 acres. Water bodies smaller than these minimums are included within the land-use unit in which they are located. Sewage-treatment or water-supply facilities are a basic part of the urban pattern and should be included in the 01-Urban category even where the unit is large enough to be separately identified. Water bodies that are vegetated are placed in the 06-Wetland category, or in Forest Land if swamp forests exist.

There are five Level II categories: Streams and Waterways, Lakes, Reservoirs, Bays and Estuaries, and Other.

51. STREAMS AND WATERWAYS

This subcategory includes rivers, creeks, canals, and other linear bodies that meet the minimum width requirement of 1/8 mile. Occasional constrictions of streams to less than 1/8 mile may be included to preserve continuity. Streams flowing through deltas will be classified as water as long as width minimums are met, but where there are many distributaries and individual streams are less than 1/8 mile wide, they will be included in the appropriate land use. Where the water course is interrupted by a control structure, the impounded area, if it exceeds 40 acres, will be placed in the Reservoirs subcategory.

The boundary between streams and lakes, reservoirs, or the ocean is the straight line across the mouth of the stream unless the mouth is more than 1 mile wide. In that case the rule given under 05–04 for bays and estuaries is followed.

52. LAKES

Lakes are bodies of water more than 40 acres in areal extent, but excluding reservoirs. Islands within lakes that are too small to delineate will be included in the water area. The delineation of a lake will be based on the areal extent of water at the time the imagery is taken.

53. RESERVOIRS

Reservoirs are artificial impoundments of water greater than 40 acres in areal extent, whether for irrigation, flood control, municipal water supplies, or hydroelectric power generation. Dams, levees, other water-control structures, or the excavation itself will usually be evident to aid in the identification.

54. BAYS AND ESTUARIES

Bays and estuaries are inlets or arms of the sea that extend into the land and as such are properly classified in this system only when they are included within the land mass of the United States. In order that this land mass area be commensurate with the area of the United States used in compiling census statistics, the convention used by the Bureau of the Census in setting the outer limits of the United States will be followed. Where bays and estuaries are between 1 and 10 nautical miles in width, the outer limit of the United States will be the straight line connecting the headlands except where the indentation of the embayment is so shallow that the water area would be less than the area of a semicircle drawn with this straight line as the diameter. In that event the coastline itself would form the outer limit of the United States. Embayments less than one nautical mile in width are classed as 05--01 Streams and Waterways. Embayments or portions of embayments more than 10 nautical miles wide are not considered as included within the land mass.

55. OTHER

Other water areas include large farm ponds that may not be identifiable as reservoirs, other water features not mentioned in the preceding categories, or combinations of water features that cannot be clearly defined.

60. Nonforested Wetland

Nonforested Wetlands consist of seasonally flooded basins and flats, meadows, marshes, and bogs. Wetlands are usually relatively level areas. Uniform identification is difficult because the wetland areas change as the result of such factors as long-term drought, high rainfall, seasonal fluctuations in precipitation, and diurnal tides. The observations must be correlated with tide and weather information to obtain consistent results.

Open saline- and fresh-water areas, sounds, and bays are included under 05-Water. Wetland areas with a 10 percent forest crown cover, or where recent clear cutting has occurred, are placed in 04-Forest Land.

Nonforested Wetland may be either Vegetated or Bare.

61. VEGETATED NONFORESTED WETLAND

Vegetated Nonforested Wetland includes areas where the forest crown cover is less than 10 percent or the vegetation is nonwoody. Cattails, tules, and grasses such as Indian rice grass and saw grass occur in fresh-water marshes, and salt-tolerant grasses such as Spartina occur in the salt marshes.

62. BARE NONFORESTED WETLAND

Tidal flats are the main component.

70. Barren Land

Barren land is land of limited ability to support life and little or no vegetation. In general, it appears to be an area of oily soil, sand, and rocks. Vegetation, if present, is more widely spaced and scrubby than that in the Desert Shrub subcategory of Rangeland except when unusual conditions, such as a heavy rainfall, occasionally result in growth of a short-lived more impressive plant cover.

Land may be temporarily barren owing to man's activities, but such land is usually included in another land-use category. Agricultural land may be temporarily without vegetation because of tillage practices. Sites for urban development may be stripped of cover before construction begins. Areas of extractive and industrial land have waste and tailings dumps, and exhausted sources of material supply are often evident.

Level II categories of Barren Land are: Salt Flats, Beaches, Sand Other Than Beaches, Bare Exposed Rock, and Other.

71. SALT FLATS

Salt flats are the flat-floored bottoms of interior desert basins. For a short time after a cloudburst, they may be covered by a sheet of water, or playa lake. On vertical air photographs they appear as white scars in the desert because the soil, flatness, and color cause a diffused reflectancy much higher than the albedo of other desert features.

72. BEACHES

Beaches are the smooth sloping accumulations of sand and gravel along shorelines. The surface is stable inland, but the shoreward part is subject to erosion by wind and water, and material is deposited in protected areas. The Beach category is not used if there is vegetative cover or another land use.

73. SAND AND OTHER THAN BEACHES

Sand Other Than Beaches is composed primarily of dunes, accumulations of sand of aeolian origin. Dunes are most commonly found in deserts although they also occur on shore and strand lines, coastal plains, river flood plains, deltas, and in periglacial environments. They are of various shapes, the crescentic being the most elementary, and range in size from diameters of a few to several thousand meters and in height from one to several hundred meters. Isolated crescent-shaped dunes migrate freely, but longitudinal dunes tend to remain nearly fixed in position.

74. BARE EXPOSED ROCK

The Bare Exposed Rock category includes areas of bedrock exposure, desert pavement, scarps, talus, slides, volcanic material, and other accumulations of rock without vegetative cover.

75. OTHER

This subcategory is used for a mixture of Barren Land features or when a Barren Land subcategory cannot be positively identified.

80. Tundra

Tundras are cold treeless lands, primarily in Alaska, with a vegetative cover of moss and lichen, grasses, and shrubs. The tundra zone can be divided into three subzones on the basis of vegetative cover: an arctic subzone characterized by an interrupted cover of sparse moss and lichen sedges: a typical tundra subzone characterized by various types of moss and lichen sedges and rare shrubs in river valleys; and a shrub tundra subzone, characterized by birch and willow shrubs together with mosses, sedges, and grasses. Mountain tundra, along the mountain tops, extends well to the south and is enriched by alpine flora.

The interfaces of Tundra to Permanent Snow and Icefields and to Water are fairly easily determined if the imagery is taken in late summer. Between Forest Land with a light crown cover and Tundra, the boundary tends to be transitional over a wide area and is also uneven, as changes in growing conditions bring about protuberances of brushland into Tundra areas. Distinguishing between Tundra and Nonforested Wetland is difficult where there is a hummocky landscape with intervening areas of standing water. Flooded portions may vary in size owing to seasonal changes in depth of frost, amount of precipitation, and evapotranspiration potential. The ratio of flooded land to vegetation is the basis for decision. The Barren Land-Tundra interface occurs where one or more of the vegetative growing factors are deficient. The boundary will be difficult to establish.

90 . Permanent Snow and Icefields

Permanent Snow and Icefields are those that survive summer ablation. Snow, firn, icepacks, icecaps, and glaciers are included and the underlying mass may be either land or water. An average frontal position over a period of a few years would be the most desirable border, but an expedient delineation can be made through observations at the time of maximum retreat, probably during August in the northern hemisphere. The abutting land would most probably be classed as Water, Barren Land, Tundra, or Nonforested Wetland.

APPENDIX 2:
1970 LAND USE CLASSIFICATION SCHEME DEFINITIONS

INTRODUCTION

The Land Use Classification Scheme for the detailed 1973 Maryland Land Use Inventory is an expansion of the Scheme used for the 1970 CARETS Land Use Inventory developed by Anderson *et al* (1971). The present classification scheme is designed for use with high altitude aerial photography and selective (minimal) use of collateral data. Mapping base, by Maryland counties, is 1" = 1 mile (1:63,360). Minimum size specifications for land use categories are:

A. - No area will be recognized unless it is at least 10 acres in size; and

B. - Units less than 530 feet wide will not be shown, except as acute corners of larger types, or extremely elongated cultural features. (The 10 acre minimal also applies to linear types).

DEFINITIONS

Definitions provided below are *in addition* to those described in USGS Circular 671; where the two schemes are in conflict, the present discussion takes precedence.

110 - Residential - Single and multiple unit dwellings and yards and associated areas.

- 111 - Single Unit Residential - Detached, single family/duplex dwelling units.

A. Low SUR Density -

B. Medium SUR Density -

C. High SUR Density -

112 - Multi - unit Residential - Attached single unit row housing, garden apartments with extensive common areas, high-rise apartment/condominium buildings.

A. Low MUR Density - not more than 3 stories nor more than 12 units/acre.

B. High MUR Density - more than 3 stories or with more than 12 units/acre.

113 - Mobile home and Trailer parks and associated areas.

120 - Retail and wholesale services. Areas used primarily for the sale of products and services, including associated yards and parking areas.

121 - Retail sales and services (commercial)

Retail sales, services, and offices, including drive-in theaters, central business districts, neighborhood and regional shopping centers, and strip of roadside commercial developments, hotels and motels, and government (city, county, state, and federal) buildings (not including schools, churches, or cemetaries).

122 - Wholesale and services and light industries - wholesale sales and services, including trucking companies and warehousing, and associated yards and parking areas. Also, light industrial and manufacturing facilities

and parks including associated areas. Light industry includes manufacturing, construction, processing, and laboratory facilities other than those identified in heavy industry.

130 - Industrial - Heavy manufacturing and industrial parks including associated warehouses, storage yards, research laboratories, and parking facilities, including the following types:

131 - Heavy Industries - heating processing, including primary metals industries and electric power generation.

132 - Heavy Industries - metal processing, including fabricated metal products and assembly.

133 - Heavy Industries - Chemical processing, including paper and allied products, petroleum refining, and petrochemical and chemical industries.

140 - Extractive - Surface mining operations including sand and gravel pits, above quarries, and coal mines. Base soil or tailings areas are considered part of this category. Status of activity (active vs. abandoned) is not distinguished.

141 - Coal (surface mines) - occur only in Garrett and Allegany Counties, Maryland.

142 - Other Quarries and Pits - include sand, gravel, and stone.

150 - Transportation, Communication, and Utilities.

151 - Airports and associated features - Public and military airports, including runways, parking areas, hangars, and terminals.

152 - Railroads, including yards and terminals which meet minimum size (width) specifications.

153 - Freeways and highways, including interstate and multi-lane state highways, interchanges, and rights of ways which meet minimum size (width) specifications.

154 - Marine terminals - large commercial and military ports and associated facilities. This category does not swell, local marinas which are less than 10 acres.

155 - Utilities - water supply, sewage treatment, oil and gas delivery facilities, electric transmission stations, and telecommunication facilities.

160 - Educational (Institutional)

161 - Elementary Schools

162 - Secondary Schools - Junior High and Senior High Schools.

163 - College and University - both public and private.

164 - Military facilities - built-up areas only, including buildings, storage, training, and other areas.

165 - Other Institutional - Includes churches, medical and health facilities, correctional facilities, and government facilities which may be identified as such from aerial photography or collateral data.

170 - STRIP and Clustered

Includes residential, commercial, etc. in small settlements and along transportation routes where separate land use categories cannot be delineated. Efforts are to be made to minimize occurrence of this category.

190 - Open and Other (Urban)

Urban areas whose use does not require structures or where areas of non-conforming uses have become isolated. Included are golf courses, parks and recreation areas (except areas associated with schools, etc.), cemetaries, entrapped agricultural and undeveloped land within urban areas.

210 - Crop and Pasture Land.

211 - Crop land - Land used to produce row, field, and truck crops such as corn, wheat, soybeans, and garden vegetables.

212 - Pasture land - land used for pasture.

220 - Orchards - areas of bush and tree crops used for fruit production.

230 - Feeding Operations - includes cattle feed lots (including holding lots for dairy animals), poultry houses, and Hog feed lots.

400 - Forest Land

The following descriptions apply to all sub-classes of forest land.

These lands are at least 10% stocked with trees capable of producing timber or other wood products, and lands dedicated to forest production but temporarily cleared (i.e. logged). These lands include abandoned fields with woody brush that prevents classification as Agricultural land.

Any lands that meet the above requirements and also those for a higher use category should be placed in the higher category.

410 - Deciduous Forest Land

his class includes all forested areas in which the trees characteristically lose their leaves at the end of the growing season. This includes such species as: oaks, hickory, aspen, sycamore, birch, yellow poplar, elm, maple, cypress.

411 - Upland Deciduous Forest Land

This class includes those species that grow on upland, relatively well drained sites. This includes such species as: white oak, hickory, chestnut oak, aspen, cherry.

412 - Lowland Deciduous Forest

This class includes those species that occur on low moist sites, frequently poorly drained and may have intermittent standing water. This includes such species as: river birch, sycamore, red maple, sweet gum, ash, elm, tupelo;.

420 - Evergreen Forest Land

This class includes all forested areas in which the trees are characterized by persistent foliage throughout the year. This includes such species as: white pine, loblolly pine, pond pine, hemlock, southern white cedar, red pine.

421 - Upland Evergreen Forest Land

Those lands classified are evergreen forests that occur on upland, relatively well drained sites.

422 - Lowland Evergreen Forest Land

Those lands classified as evergreen forests that occur on lowland, wet, poorly drained sites. These sites may have intermittent periods of standing water.

430 - Mixed Forest Lands

This class includes all forest lands in which deciduous or evergreen types do not predominate.

431 - Upland Mixed Forest Lands

Those lands classified as mixed forest lands which occur on upland, relatively well drained sites.

432 - Lowland Mixed Forest Lands

Those lands classified as mixed forest lands which occur on lowland, wet, poorly drained sites which may have intermittent periods of standing water.

440 - Upland Brush

This includes those lands classified as Forest Lands and do not produce timber or other wood products. These lands occur on relatively well drained, upland to rolling terrain. This includes such vegetation types as sumac, vines, rose, brambles, etc.

600 - Non Forested Wetland

This class includes all wetland areas with less than 10% forest cover woody vegetation.

610 - Vegetated wetlands

Those lands classified as non-forested wetlands characterized by woody or non-woody vegetation.

620 - Non-vegetated wetlands

Those lands classified as non-forested wetlands with no predominate vegetation type that is persistent. This includes primarily tidal flats.

510 - Rivers - waterways, shown as linear features, which exceed minimum size (width) specifications.

530 - Reservoirs - Artificial water impoundments (Note: there are no natural lakes in the State of Maryland; all closed water bodies are by definition reservoirs).

720 - Beaches - extensive shoreline areas of sand and gravel accumulation. This category is not used if there is vegetation cover or another land use.

740 - Bare Exposed Rock - areas of bedrock exposure, scarps, and other natural accumulations of rock without vegetative cover.

APPENDIX 3:
1938-1952 LAND USE CLASSIFICATION SCHEME DEFINITIONS

The following definitions were used in the Land Use Classification Scheme for 1938 and 1952 Maryland Land Use Inventories. The categories are modified from the U.S.G.S. classification scheme, Appendix 1.

11. Low Intensive Urban

Urbanized and residential regions comprise areas of intensive use, with much of the land occupied by structures. This category includes linear residential and commercial development along transportation routes including peripheral areas adjoining the urban centers.

Sporadic clustery of residential units are included, with the delineation of the boundary vague and difficult to discern.

Included in this category are city, towns and villages. Boundary limits again are somewhat vague, but the classification is limited to single unit dwellings and yards and associated areas.

12. High Intensive Urban

This category includes high density residential units, commercial, institutional, and military areas.

Again boundary limits between categories, Low Intensive Urban (11) and High Intensive Urban (12) may be vague.

13. INDUSTRIAL - same as U.S.G.S. definition for "13", Industrial.

14. EXTRACTIVE - same as U.S.G.S. definition for "14" - Extractive.

15. TRANSPORTATION, COMMUNICATIONS, & UTILITIES - same as U.S.G.S. definition for "15", Transportation, Communications, & Utilities.

19. OPEN & OTHER (Urban) - same as U.S.G.S. definition for "19", Open & Other.

21. CROPLAND AND PASTURE - same as U.S.G.S. definition for "21", Cropland & Pasture.

22. ORCHARDS, GROVES, BUSH FRUITS, VINEYARDS, AND HORTICULTURAL AREAS - same as U.S.G.S. definition for "22" . . . .

40. FOREST COVER - same as U.S.G.S. definition for "40" Forest Cover.

43. SHRUB - same as U.S.G.S. definition for "43" shrub.

51. STREAMS AND WATERWAYS - same as U.S.G.S. definition for "51" - Streams and Waterways.

52. LAKES - same as U.S.G.S. definition for "52", Lakes.

53. RESERVOIRS - same as U.S.G.S. definition for "52", Reservoirs.

54. BAYS & ESTUARIES - same as U.S.G.S. definition for "54" Bays and Estuaries.

61. VEGETATED WETLAND - same as U.S.G.S. definition "61" - Vegetated Non Forested Wetland.

72. BEACHES - same as U.S.G.S. definition for "72" Beaches.

APPENDIX 4:
PROPOSED USGS LAND USE CLASSIFICATION SCHEME CHANGES

The following Land Use Classification system is a modification of the system adopted by the State of Maryland as presented in U. S. Geological Survey Circular 671 (1972).

An assessment of the original system was proposed to accommodate revisions that have been proposed as a result of a nationwide survey. In the assessment of the recommended changes, keep in mind the following:

1. Remote sensor data are intended to be the primary source of data at the national level.

2. At Levels I and II, an interstate perspective on land use is being emphasized.

3. Categorization at Level II is appropriate to a presentation scale ranging from about 1:50,000 to 1:250,000.

4. A compilation scale ranging from 1:125,000 to 1:125,000 permits delineation of areas as small as 10 acres with some difficulty. Such a 10-acre minimum delineation unit appears to be desirable for some Level II land uses delineated at the above range in scales.

5. A cover orientation to land use classification is necessary if remote sensor data are to be used effectively. However, a comparison of many existing land use classification systems that are presumably more activity oriented shows that in reality there is not necessarily too much difference between them and the proposed cover orientation used in USGS Circular 671. For example, the Standard Land Use Coding Manual which presents an activity oriented system has urban and built-up categories such as: residential, commercial, services, and transportation. The USGS system presented in Circular 671 also has these categories.

6. The system proposed is not completely logical from a classification standpoint. There is a compromise between what is considered necessary by many users and what has actually been demonstrated to be obtainable from remote sensor data sources. Such a compromise seems justified from the standpoint of keeping the system cost-effective for use over extensive areas. If more detail is needed and if funds are available to turn to more expensive ground observation and enumeration, then by all means the user can and should do so by developing a satisfactory categorization for specific uses which extend beyond Level II in terms of detail desired. Careful consideration must also be given to the development of an information system which permits other kinds of land use data such as recreational uses of land, for example, to be geographically related to a general land use or cover data base such as that proposed in USGS Circular 671.

7. It is recognized that what may be a primary category for one agency or state may well be of secondary importance to another. For example, in any of the Western States it would be ridiculous to publish a map of current land use without having irrigated land as a major category. With the flexibility proposed in USGS Circular 671, it is assumed that such an accommodation can easily be made. The main requirement is that irrigated land components be discreet units capable of being integrated into the more general categories of cropland and pasture and orchards, groves, vineyards, etc., which are included in the proposed framework for standardization as follows:

   For example, possible accommodations to USGS Circular 671 by Western States might be made along this line:

   Irrigated agricultural land
       Cropland (can be further broken down into types if desired)
       Pasture (can be further broken down into types if desired)
       Orchards, Groves, Vineyards and Ornamental Horticultural Areas (can be broken down further in several ways)

   Non-irrigated agricultural land
       (same sub-categories as above)

   By adding irrigated and non-irrigated cropland and pasture categories together the total cropland and pasture category at Level II in Circular 671 can be obtained.

LEVEL I CHANGES BEING PROPOSED ARE:

1. Drop Non-forested from Wetland at Level I. At Level II have Wetland sub-categories - Forested and Non-forested. We now believe we can delineate swamp forests, etc., if we have winter and summer ERTS imagery plus color IR high altitude imagery taken in winter. Originally we assumed considerable difficulty in making this separation without seasonal enhancement. While we cannot assume such seasonal enhancement will always be available, we now believe that, with some use of supplemental materials, we can make a reasonably good delineation of forested wetlands at the Level II scale of generalization.

2. A slight re-ordering of categories is being proposed in order to have an arrangement ranging generally from more intensive to less intensive uses and from vegetated to non-vegetated.

3. Zeros (0) are being dropped from the numerical designation.

4. Permanent Snow, Icefields and Glaciers should be used in place of Permanent Snow and Icefields.

Recent consultation and correspondence with state planning officials and researchers on remote sensor technology in Alaska strongly indicates that "Permanent Snow, Icefields and Glaciers," and "Tundra" should be retained as Level I categories in a national system. Tundra conditions cover an estimated 183 million acres; and Permanent Snow, Icefields and Glaciers cover about 11 million acres in Alaska.

LEVEL II CHANGES BEING PROPOSED ARE:

1. Institutional would be combined with Commercial and Services. On the basis of the interpretation experience on the USGS Central Atlantic Regional Ecological Test Site (CARETS) Project, the Tennessee Valley Authority project, and on the basis of comments already received, this category cannot be consistently separated from the Commercial and Services category. Since institutional uses are primarily public services, a combination with the Services category will be consistent with the *Standard Land Use Coding Manual* categories.

2. Extractive would be retained as a sub-category in Urban and Built-up. *However*, only those extractive activities having structures such as an oil field with closely spaced wells or a shaft mine with structures on the surface or other structures such as machinery repair shops, etc., associated directly with the mining activity would be included under this category. Strip mines, quarries, gravel pits, etc., both active and inactive, would be included as a sub-category under Barren Land. It is not always possible to distinguish active from inactive strip mines, etc. After a strip mined area has been revegetated it would be classified in accordance with the existing uses or cover.

3. Since the geographical position of Strip and Clustered Settlement generally makes it possible to identify such areas separately if required, it seems desirable not to have a sub-category for what really is a pattern of land use rather than a specific use. Industrial parks in which a mixture of commercial, service, and industrial activities generally occur will also be included under "Mixed."

4. The definition for residential will be restructured in order to include rural residential subdivisions (second home, retirement, etc.). This will require that attention will need to be given to possible differences in housing densities in rural situations separated from suburban residential situations.

5. Bush fruits are being dropped from "Orchards, Groves, Vineyards, and Ornamental Horticultural Areas" because of the difficulty of identification and because such crops are generally separated from tree fruits, etc., in agricultural statistics.

6. The word "confined" is being used with Feeding Operations to indicate more clearly that pasture areas, etc., are not to be included as Feeding Operations. Only larger confined feeding operations can be positively identified satisfactorily from high altitude aircraft imagery. Smaller feedlots, etc., could be plotted when the compilation and publication scales permit presentation of such areas. Some thought was given to dropping this Level II category but the disposal of animal wastes is of considerable significance and some persons have urged that we retain this category.

7. A breakdown of Wetland into Forested and Non-forested would be made in general conformity with definitions of Wetlands as contained in USDI Circular 39 "Wetlands of the United States," except that wet tundra and other Artic and subarctic conditions should be recognized. This was the definitional structure used originally in Circular 671 in defining Non-forested Wetland. This definition is as follows:

   > "Lowlands covered with shallow and sometimes temporary or intermittent waters. They are referred to by such names as marshes, swamps, bogs, wet meadows, potholes, sloughs, and river-overflow lands. Shallow lakes and ponds, usually with emergent vegetation as a conspicuous feature, are included in the definition, but the permanent waters of streams, reservoirs and deep lakes are not included. Neither are water areas that are so temporal as to have little or no effect on the development of moist-soil vegetation." (p. 2, USDI Circular 39)

   While the definition of Wetland as contained in USDI Circular 39 is currently being re-evaluated in the context of pending and existing legislation in many states and by researchers concerned with wetland problems, it seems desirable to retain a definition based on vegetative cover in the USGS classification system as the most meaningful approach for use with remote sensor data. A classification system that recognizes soil moisture and other conditions associated with wetlands may also be needed for planning, management, and other purposes.

8. "Grass" would be replaced by the term "Herbaceous Range" in order to have more accurate designation of a category that includes forbs.

9. Savannas (Palmetto Prairies) would be dropped because of its localized occurrence. Including such a category at Level II is not in keeping with the national and interstate regional perspective that is being associated with the more generalized levels in the proposed classification system.

10. "Chaparral" and "Desert Shrub" are being replaced by a more inclusive category entitled "Shrub-Brushland Range." The definition of this proposed category would be written to include brushland areas often being pastured or previously pastured in the eastern United States. Generally such areas have not been included in range. Neither do such areas in the East really fit under forestland until grazing ceases or until sufficient growth has occurred to make a clearcut identification as deciduous, evergreen, or mixed forestland.

11. "Waterways" has been dropped from "Streams and Waterways" because of implied use of streams for transportation when such use cannot always be clearly identified from remote sensor data. Use of streams, lakes, etc. for transportation can best be determined from other data sources and added as an overlay to a basic land use data base.

12. Although the term "beaches" does not imply the presence of a particular type of material, questions have been raised about the inclusion of mudflats. It has been proposed that such areas are, therefore, more appropriately included under barren land than under wetland.

13. Strip mines, quarries, and gravel pits (see Item 2 above under Level II) are now included under "Barren Land."

14. "Transitional Areas" is proposed as an additional category under Barren Land in order to have a category within the system where changes in land use actually in progress can be clearly and separately identified from an "other" category. Such a category would include forestland areas being cleared for agriculture, areas temporarily bare or on which construction is starting for residences, shopping centers, industrail parks, suburban and rural residential subdivisiona, etc.

Areas changing from some uses to other uses cannot always be readily detected while the change is actually occurring; for example, rangeland to cropland. Therefore, it will be important to define this category carefully.

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